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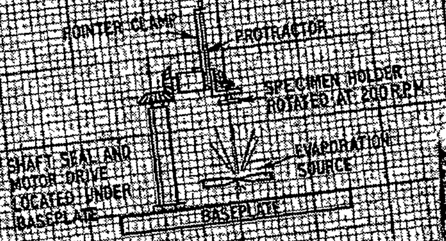
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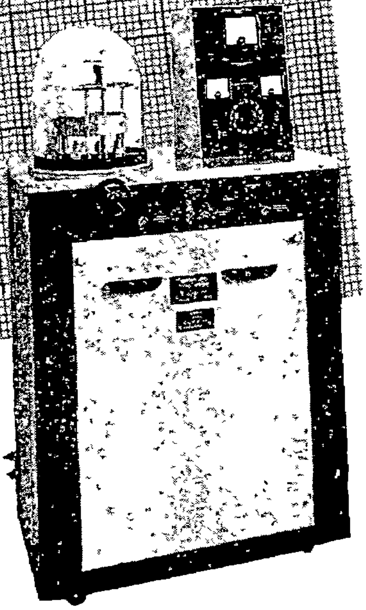

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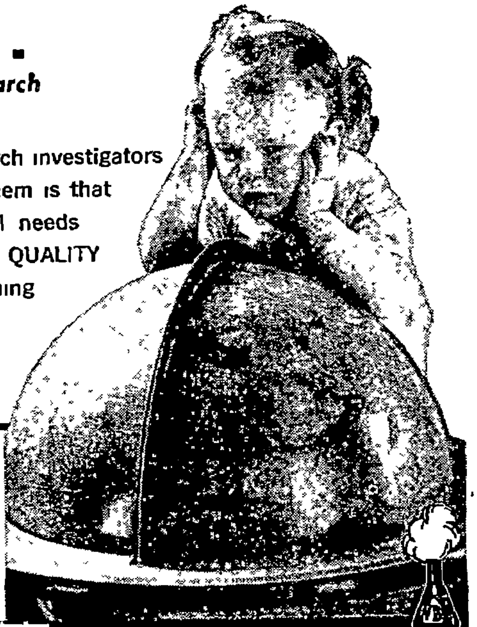

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NATURE

No 4692 SATURDAY, OCTOBER 3, 1959 Vol. 184

Page
National Parks and Nuclear Power Stations in Britain . 1005

The Earth as Viewed in 1959 By Prof B Gutenberg 1007
Gemmology By Dr W Campbell Smith, C B E . 1008
Trends in Statistics Teaching By J Durbin 1008
The Culture of Cells By Dr I Leslie 1009
Measurement of Values By Prof Ll. Wynn Jones 1010
Cacti By N Y Sandwith 1010

Cytoplasmic Inheritance By Prof D G Catcheside, F R S 1012
Thermonuclear Research in Great Britain. By Dr R Latham . 1015
Pugwash International Conference of Scientists 1018

Obituary:

Dr B van der Pol. By Dr R L Smith-Rose, C B E . . 1020

News and Views 1021

Development Trends in Australian Scientific Research . . . 1027
Delayed Hypersensitivity in Immunology 1029
The Electric Arc in Welding By D R Milner 1030
International Congress on Acoustics. By Prof E G Richardson . 1031
Photography in the International Geophysical Year By Dr R L F Boyd 1032
Glasshouse Crops Research Institute By F W Toovey . 1033
Studies in Recreation 1034
Marital Fertility in England and Wales By Prof E Grebenik . 1035
John Innes Horticultural Institution 1036
A Revised Classification of the Ludlovian Succession at Ludlow By C H Holland, J D Lawson and V G Walmsley 1037
Effect of Some Neuromuscular Blocking Agents on Mitochondrial Enzyme Systems By Dr J H Koch and Dr C H Gallagher 1039
Effect of Dietary Fat and Extent of Blood Sampling on the Level of Plasma Cholesterol in the Rat By I Coleman and J M R Beveridge 1041
Nonhæm Iron in Erythrocytes as a Precursor for Hæmoglobin By Dr M Faber and Dr I Falbe-Hansen 1043
Extreme Sensitivity of Germination and Photoperiodic Reaction in the Genus *Chenopodium* (Tourn) L By Dr Bruce G Cumming 1044
Redox Potentials in Soybean Nodules during the Vegetative Period By Dr Helena Ebertová 1046
Photoreactive Pigments in Flagellates By Dr Mary Belle Allen, Dr Ellsworth C Dougherty and Dr John J A McLaughlin, Dr C Ó hEocha and M Raftery, Dr F T Haxo and D C Fork 1047

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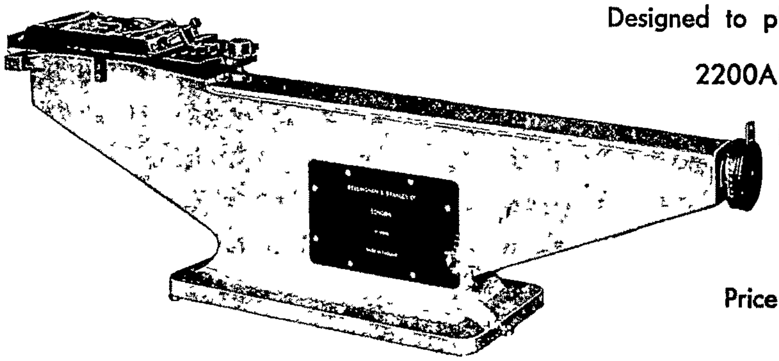

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NATURE

No. 4693 SATURDAY, OCTOBER 10, 1959 Vol 184

CONTENTS

Page

THE DEVELOPMENT OF PUBLIC SERVICES IN A MODERN DEMOCRACY . 1087

BRITISH INDUSTRY By Prof A J Brown 1089
TURNING POINTS IN PHYSICS By G R Noakes 1090
CATALYTIC PROCESSES AND PETROLEUM By Dr David M Wilson . 1090
SEX ON THE FARM By Dr S J Folley, F R S . 1091
HÆMOGLOBIN AND SENSORY MECHANISMS By P A Merton 1092
COLOUR REPRODUCTION By Dr W S Stiles, O B E , F R S . 1092

PREPARATION OF DIAMOND By Drs H P Bovenkerk, F P Bundy, H T Hall, H M Strong and R H Wentorf, jun . 1094
Fasciculus limpidus NOV GEN , NOV SPEC , A REPRESENTATIVE OF A NEW GROUP OF BACTERIA By Prof E G Pringsheim . 1098
BIOLOGICAL PROBLEMS ARISING FROM THE CONTROL OF PESTS AND DISEASES By Dr E B Worthington . 1100
DARWIN'S ILLNESS By Prof S Adler, O B E , F R S 1102

OBITUARIES
MR J T DAVEY and MR H J MORRIS. By Dr T H C Taylor 1104

NEWS AND VIEWS . . 1105

MELLON INSTITUTE 1109
LABOUR TURNOVER By T H Hawkins . . 1110
STRONTIUM-90 IN HUMAN DIET By Dr J M A Tilley 1111
IMMEDIATE AND LOW-LEVEL EFFECTS OF IONIZING RADIATIONS By Dr TIKVAH ALPER 1111
NUCLEAR FORCES AND THE FEW-NUCLEON PROBLEM By T C Griffith and E A POWER 1113
CHAGAS'S DISEASE By Dr J D Fulton 1114
SPECIAL CERAMICS By Dr N F Astbury 1115
SOLID STATE PHYSICS By W M Lomer 1117
UNIVERSITY GRANTS IN GREAT BRITAIN 1118
NUCLEAR RESEARCH IN AUSTRALIA 1118
CONSERVATION OF ENGLISH WALLPAINTINGS . 1119
KELLOGG AND NEY'S MODEL OF THE SOLAR CORONA By Dr D E Blackwell and Dr D W Dewhirst , Prof Edward P Ney and Prof Paul J Kellogg 1120
PROTON RESONANCE RELAXATION TIMES IN MOBILE LIQUIDS By Dr J G Powles and D Cutler . 1123
POSSIBLE MECHANISM OF CYSTEINE PROTECTION AGAINST RADIATION CATARACT By Mrs A Pirie and L G Lajtha 1125
RELEASE OF ADENOSINE TRIPHOSPHATE AND SEROTONIN FROM INJURED CELLULAR BLOOD ELEMENTS IN EXTRACORPOREAL CIRCUITS By Dr H S S Sarajas, Dr R Kristoffersson and Dr M H Frick 1127
AMPLITUDE-MODULATION RADIO-TELEMETRY OF NERVE ACTION POTENTIALS By Roger M Morrell 1129
COMPOSITION OF A PARAFFIN WAX FRACTION FROM TOBACCO LEAF AND TOBACCO SMOKE By Dr W Carruthers and Dr R A W Johnstone 1131
HÆMOGLOBIN *P* IN A FAMILY IN THE BELGIAN CONGO By Dr Paulette Dherte, Dr H Lehmann and Dr J Vandepitte 1133
β-GLOBULIN ALLELES IN SOME ZEBU CATTLE By G C Ashton 1135

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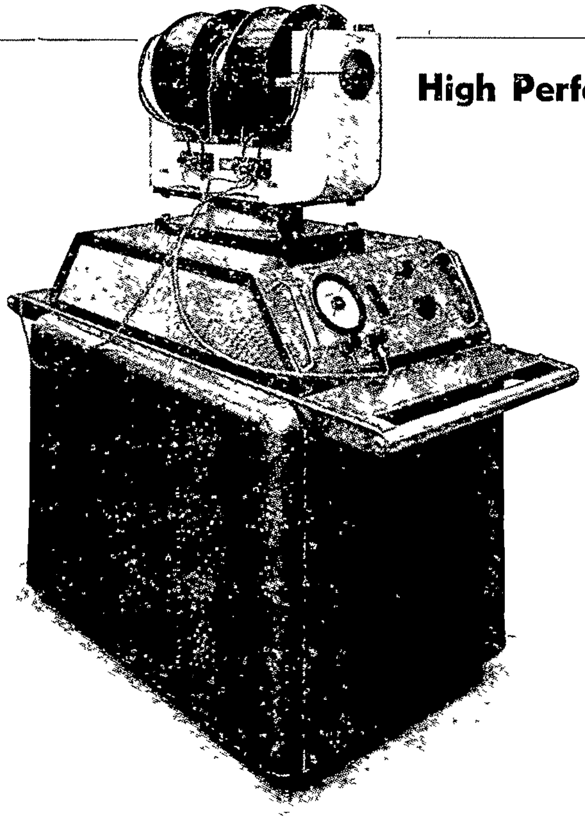

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NATURE

No. 4694 SATURDAY, OCTOBER 17, 1959 Vol. 184

CONTENTS

Page
General Education in a Modern Democracy 1171
Research in Gas Dynamics By Prof J H Horlock . . . 1173
Microscopes and Photomicrography Dr S Bradbury 1174
Low-Temperature Engineering By Dr G G Haselden . . 1174
A New Introduction to Geology By Dr J C. M Taylor . 1175
Dielectrics By Dr V Daniel . . 1175
Embryology By Sir Julian Huxley, F R S . 1176
Fourier Series By Prof T A A Broadbent . 1176

Myxomatosis Present Position and Future Prospects in Great Britain By Dr C H Andrewes, F R S, H V Thompson and W Mansi . 1179
International Council for the Exploration of the Sea By A J Lee and Dr D H Cushing 1180
Effects of Forest Areas on Water Resources, and the Technique of Lysimetry By Dr L Leyton, F W Green 1184

Obituaries
Prof. H J Backer By Prof Frederick Challenger 1187
Prof E S Salmon By Dr H H Glasscock . 1188
Prof. J Zenneck By Dr R L Smith-Rose, C B E 1188

News and Views 1189

International Union of Pure and Applied Chemistry 1193
Science and Philosophy By G E Denyer 1193
Fourteenth Annual Calorimetry Conference 1194
Second Australian Spectroscopy Conference By Norman S Ham . 1195
Protein Biogenesis By Prof H Chantrenne 1198
Progress in Gas Chromatography By C G Scott . 1199
Origin and Dispersal of Flowering Plants By Prof A S Boughey 1200
The National Health Service in Britain 1201
Preventing Juvenile Delinquency . 1203
The Origins of Love . 1203
North–South Anisotropy and Anticipatory Increase of Intensity associated with the Cosmic-Ray Storm of February 11, 1958 By Dr V Sarabhai and R Palmeira . 1204
Measurement of the Effects of Piston Mass and Bursting Pressure on the Motion of a Piston in a Hypersonic Gun Tunnel By B J Belcher . 1207
A Structural Model for Monatomic Liquids including Metallic Liquids By Dr Kazuo Furukawa 1209
Polynuclear Complexes of Molybdenum(II) By Dr J C Sheldon 1210
Massive Incorporation of 5-Fluorouracil into a Bacterial Ribonucleic Acid By Dr Jack Horowitz and Prof Erwin Chargaff 1213
Measurements of Temporal Adaptation to Spatial Detail Vision By A J Seyler and Z L Budrikis 1215
Effect of Oxygen Tension on Hæm and Porphyrin Biosynthesis By J E Falk, R J Porra, Ann Brown, F Moss and Helen E Larminie 1217
Possible Role of Higher Proprioceptive Centres in the Perception of Visual Space and in the Control of Motor Behaviour By Dr B Gurevitch 1219

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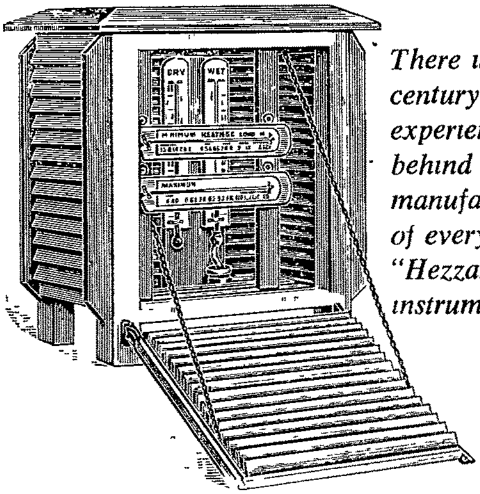

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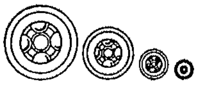

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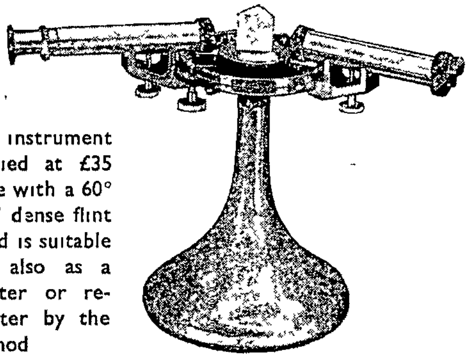

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NATURE

No. 4695 SATURDAY, OCTOBER 24, 1959 Vol. 184

CONTENTS

Page
Organization of Scientific and Technological Research in Britain 1255

The Principles and Practice of Crop Protection By F C Bawden, F R S 1258
Free Radicals By Dr T M Sugden 1259
The Importance of New Detectors 1260
The Very Cold World By Prof J F Allen, F R S 1260
A Biochemist's Guide to the Nervous System. By Dr G B Ansell 1261
Fauna of Netherlands New Guinea By J E Hill 1261

The First Minister for Science By The Right Hon Viscount Hailsham, Q C 1263
Rocket Propulsion By Dr W B Littler, C B 1264
Density of the Upper Atmosphere from Analysis of Satellite Orbits Further Results By D G King-Hele 1267

News and Views 1271

Boots' New Biological Research Laboratories By Dr G I Hobday 1274
The British Food Manufacturing Industries Research Association By Prof B R Knapp 1275
The Structure and Chemistry of Proteins By Dr E O. P Thompson 1276
Electronics Exhibition By V H Attree 1277
United Kingdom Civil Service Commission 1278
European Nuclear Energy Research 1278
The Franklin Institute 1279
Economic Developments in the Middle East By Dr Alice Garnett 1280
The Nature of Polished Metal Surfaces 1280
Eel Migration By Dr J W Jones, Dr Denys W Tucker 1281
Mechanism of Animal Joints By Dr C W McCutchen, P R Lewis and Dr C W McCutchen 1284
Experiments on the Development of Isolated Blastomeres of Mouse Eggs By Dr Andrzej K Tarkowski 1286
Metabolic and Chemical Studies of 'Myleran' Formation of 3-Hydroxytetrahydrothiophene-1,1-dioxide *in vivo*, and Reactions with Thiols *in vitro* By Dr J J Roberts and Dr G P Warwick 1288
Registration of the Spermicidal Effects of Dioctyl Sodium Sulphosuccinate By Prof Per Eric Lindahl and Kjell Wedin 1289
Glucose-6-Phosphate Dehydrogenase and Human Erythrocytes By Dr Henry N Kirkman, Dr Paul E Carson, Stanley L Schrier and Robert W Kellermeyer 1291
X-Ray Damage and Recovery in Mammalian Cells in Culture By M M Elkind and Harriet Sutton 1293
Tallowy Discoloration in Cheddar Cheese By F Bishop, C G Rammell 1295
Non-inverted versus Inverted Plots in Enzyme Kinetics By Dr B H J Hofstee, Dr Malcolm Dixon, F R S, and Dr Edwin C Webb 1296
Two-dimensional High-voltage Paper Electrophoresis of Amino- and Other Organic Acids By Dr D Gross 1298
Action of Manganese Dioxide on Simple Carbohydrates By Dr J L Bose, Dr A B Foster, Prof M Stacey, F R S, and Dr J M Webber 1301
Cross-linking of Cellulose Acetate by Ionizing Radiation. By Dr S H Pinner, T T Greenwood and D G Lloyd 1303

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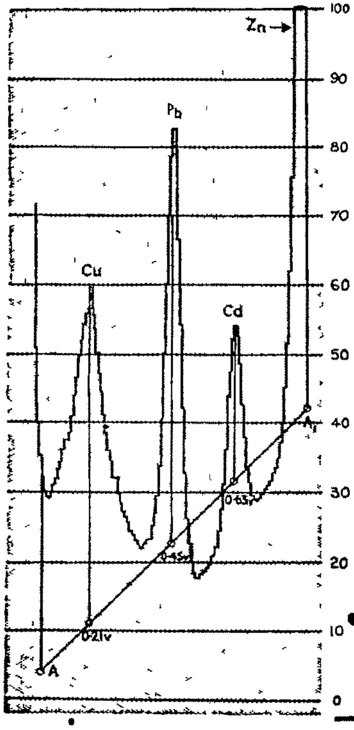

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NATURE

No. 4696 SATURDAY, OCTOBER 31, 1959 Vol. 184

CONTENTS

Page
Taxation of Learned and Professional Societies in Britain 1343

Kew, Past and Present By Dr Richard A Howard 1345
Jet Propulsion By D G King-Hele 1346
Nuclear Fuel Treatment By Dr J E Littlechild 1346
Food Analysis By Dr V H Booth 1347
A Flora of the Arctic By R D Meikle 1347
New Ideas for Industry By Prof A J Brown 1348
The Future of the Etruscans By Mrs Madeleine Smith 1348

A New Experimental Test of Special Relativity By J P Cedarholm and Prof C H Townes 1350
Echo-Location among *Collocalia* By Lord Medway 1352
Ionization Phenomena in Gases By J Dutton, D Harcombe and E Jones 1353
Radio Echo Observations of Venus By J V Evans and G N Taylor 1358

Obituaries
Prof M Caffrey By Prof R McKay 1359
Dr E J Holmyard By Prof J R Partington, M B E 1360

News and Views 1360

Assistance for Under-developed Countries 1363
New Research Laboratories for the Cambridge Instrument Company, Ltd By Dr M C Marsh 1364
Carbon-Dating Conference at Groningen By Dr H Godwin, F R S. 1365
Enzymes in the Food Industry 1366
Biochemical Research in India By Prof P S Sarma 1367
National Vegetable Research Station By J A Nelder 1368
The Grassland Research Institute 1370
Scientific Research in Alberta 1370
Biology of *Amoeba* By Sister Monica Taylor 1371
Value of Contour Analysis in Equatorial Meteorology By D H Johnson and Dr H T Morth 1372
Permanent Moisture Expansion of Clay Products on Natural Exposure By J S Hosking and H V Hueber 1373
Existence of an Inner Auroral Zone By Dr Knud Lassen 1375
Isomers of Vitamin A in Fish Liver Oils By Patricia S Brown, William P Blum and Max H Stein 1377
Liver Glucosyl Oligosaccharides and Glycogen , Carbon-14 Dioxide Experiments with Hydrocortisone By Dr Hsien-Gieh Sie, Prof James Ashmore, Dr Robert Mahler and Prof William H Fishman 1380
Release of Nucleotides from Yeast Cells By Masataka Higuchi and Prof Teijiro Uemura 1381
New Antimetabolites of Vitamin B_{12} By G M Timmis and Dr S S Epstein 1383
Low-Temperature Autoradiography for the Detection of Tritium in Tissue, with Removal of Luminescence induced by Tritium By P Pellerin, P Fallot, M Laine-Boszormenyi and F Serrel 1385
A Zoological Survey of Madagascar By Dr Renaud Paulian 1387
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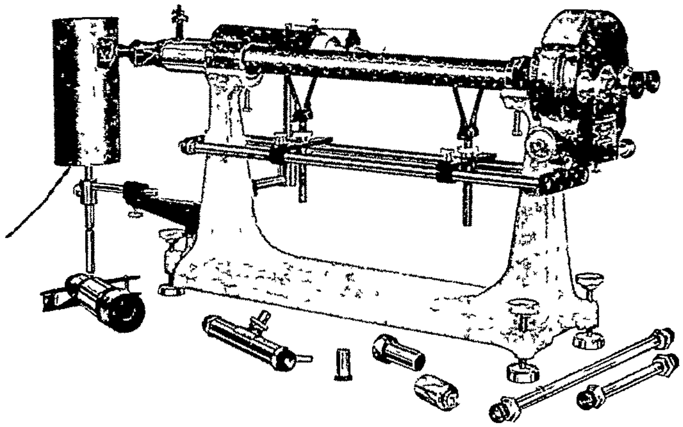

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NATURE

No. 4697 SATURDAY, NOVEMBER 7, 1959 Vol. 184

CONTENTS

	Page
EXPANSION OF UNIVERSITY EDUCATION IN BRITAIN	1431
CURRENT RESEARCH ON REPRODUCTION AND FERTILITY By Dr T Mann, F R S	1434
FORMALIZATION OF CONSTRUCTIVE CONCEPTS By Dr Hao Wang	1435
BIRDS OF PREY By Sir Landsborough Thomson, C B , O B E	1435
KEEPING UP TO DATE WITH CHROMATOGRAPHY By Dr R Consden	1436
NEW TECHNIQUES IN PACKAGING By Dr V G W Harrison	1437
TECHNOLOGISTS AND TECHNICIANS	1437
RECENT WORK ON THE ELECTRON MICROSCOPY OF VIRUSES By Dr Kenneth M Smith, C B E , F R S	1440
COMPARATIVE STUDIES OF ULTRASTRUCTURE IN BIOLOGY By Dr J Lowy	1445
NEWS AND VIEWS	1447
CHEMISTRY IN THE EIGHTEENTH CENTURY By Dr Andrew Kent	1452
FAST CHEMICAL REACTIONS IN SOLUTION By Prof G Porter and F Wilkinson	1453
SWISS SOCIETY FOR NATURAL SCIENCES By Dr R C H Tanner	1454
SCIENCE AND THE LIBRARY SERVICES IN BRITAIN	1455
INDUSTRY AND HEALTH IN BRITAIN	1456
THE BRITISH FORESTRY COMMISSION	1457
ULTRASONIC BARIUM TITANATE ADHESION AND PASTE TRANSDUCERS By Dr A Lutsch	1458
INCORPORATION OF N-METHYL CARBON OF MONOMETHYLAMINOAZOBENZENE INTO POLAR DYES By Prof Hiroshi Terayama, Prof Morizo Ishidate and Akira Hanaki	1460
OXYGEN-CONTAINING FUNCTIONAL GROUPS IN THE ORGANIC MATTER OF A PODZOL SOIL By J R Wright and M Schnitzer	1462
ACTIVE PRINCIPLES OF THE NEUROHYPOPHYSIS OF COLD-BLOODED VERTEBRATES By B T Pickering and Prof H Heller, Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke , Panayotis G Katsoyannis and Prof Vincent du Vigneaud	1463
COUNTER-CURRENT DISTRIBUTION OF PROTEINS IN AQUEOUS POLYMER PHASE SYSTEMS By Per-Åke Albertsson and Ed Jacques Nyns	1465
PROPERTIES AND INHERITANCE OF HÆMOGLOBIN BY ASYMMETRIC RECOMBINATION By Dr Harvey A Itano and Elizabeth Robinson	1468

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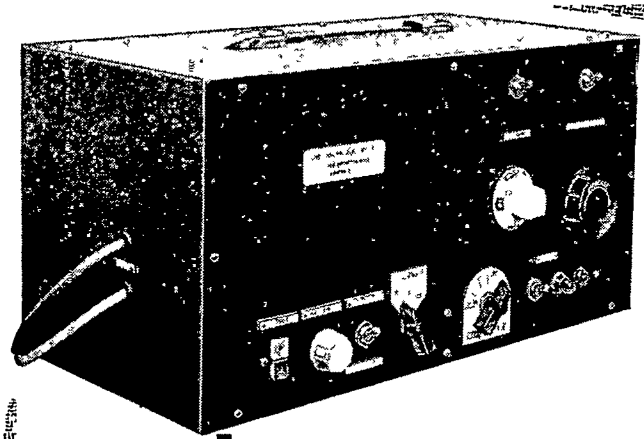

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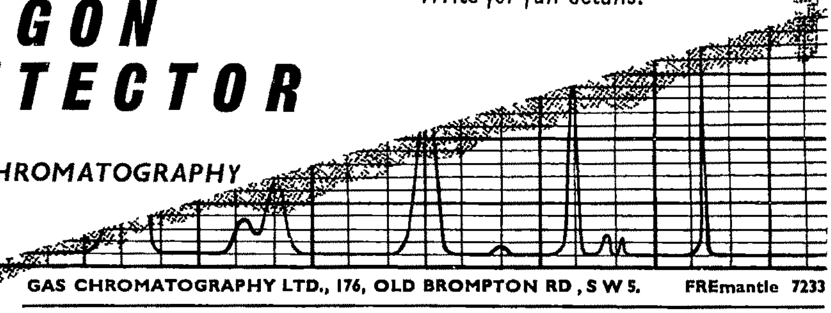

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NATURE

No 4698 SATURDAY, NOVEMBER 14, 1959 Vol 184

CONTENTS

Page

Under-developed Territories and their Problems 1519

Numbers of People By Dr B Benjamin 1521
Steric Effects in Organic Molecules By Dr G Eglinton 1522
Colorimetry By J King 1522
Statistical Methods By W J Langford 1523
Perception and Learning By Prof O L Zangwill 1523
Nuclear Energy and Analysis By G W C Milner 1524
North American Mammals By Peter Crowcroft 1524

Spiral and Other Growth Forms of Synthetic Diamonds A Distinction between Natural and Synthetic Diamond By Prof S Tolansky, F R S , and Dr I Sunagawa 1526
A Viviparous Deep-Sea Jellyfish By Dr F S Russell, C B E , F R S 1527
Conservation in the Scottish Highlands By Dr W O Binns 1529

Obituary

Prof G O Sherrard By Prof E Clarke and A Turner 1531

News and Views 1531

British Iron and Steel Research Association By D U Hunt 1536
Computer Laboratory at the University of Liverpool 1537
British Electrical and Allied Industries Research Association By Prof J Greig 1538
Flow Properties of Biological Systems By Dr G W Scott Blair 1539
British Colonial Territories 1541
Germ-free Vertebrates Present Status By Dr A W Gledhill 1541
Water Pollution Research, 1958 By D F Westlake 1542
University of Oxford Second Tanganyika Expedition By R Davis 1543
Geomagnetic Activity at Halley Bay on Disturbed Days By J MacDowall 1543
An X-Ray Study of Rigid-Body and Internal Vibrations of Organic Molecules By Dame Kathleen Lonsdale, D B E , F R S , and Dr H Judith Milledge 1545
Floral Morphology and the Taxonomy of Eucalyptus By Dr D J Carr and S G M Carr 1549
Various Types of Acquired Resistance to Experimental 'Allergic' Encephalomyelitis By G J Svet-Moldavsky, I A Svet-Moldavskaya and L I Raffkina 1552

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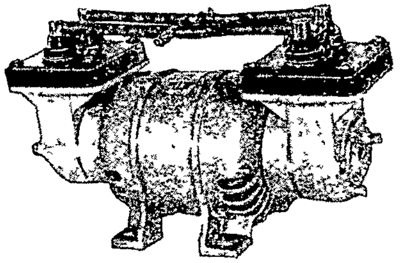

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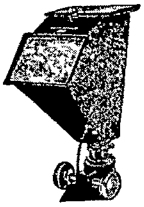

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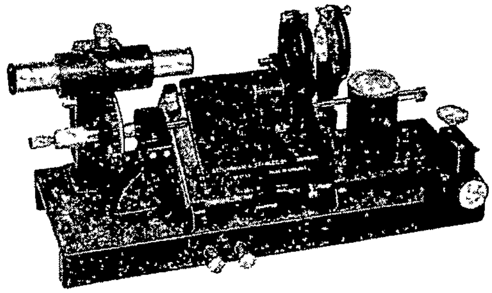

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NATURE

No. 4699 SATURDAY, NOVEMBER 21, 1959 Vol. 184

CONTENTS

Page

Impact of Science and Technology on Humanism 1595

Man-made Drugs By F R. Batchelor 1597
Microbes on the Move By Dr N Blakebrough . 1598
The Periodic Law By Prof S I Tomkeieff .. . 1598
X-Ray Powder Methods By Prof H Lipson, F R S 1599
Glove Boxes and Shielded Cells 1599
Matrix Algebra in Structural Analysis By R K Livesley . 1600
The Geological Development of North America By Dr J W Cowie 1600

The Botanic Gardens, Singapore, 1859–1959 By H M. Burkill .. 1602
International Oceanographic Congress By Dr G E R Deacon, C B E, F R S 1605
Developments in Thermodynamics By Dr H A Skinner, K Schafer and J S Rowlinson 1606

Obituary

Prof F Kogl By Prof G. J M. van der Kerk . 1609

News and Views 1610

Institute of Personnel Management 1614
Alkali Ion Determinations by means of Glass Electrodes By J O. Isard 1616
Polarization of Light from Noctilucent Clouds By Georg Witt 1618
Reductive Photo-bleaching of Eosine By Shunji Kato and Masao Koizumi, Kengo Uchida, Shunji Kato and Masao Koizumi . 1620
Control of Hatching in the Prediapause Eggs of *Aedes* Mosquitoes By Dr J D Gillett 1621
Role of a Dagger Nematode (*Xiphinema* sp) in Outbreaks of Plant Diseases caused by Arabis Mosaic Virus By Dr B D Harrison and Dr C H Cadman 1624
Ultracentrifugation and Staining of *Hevea* Latex By G F J. Moir 1626
Glycoproteins of Human Cerebrospinal Fluid By Dr Samuel Bogoch 1628

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NATURE

No 4700 SATURDAY, NOVEMBER 28, 1959 Vol. 184

CONTENTS

Page

SECONDARY AND HIGHER EDUCATION IN BRITAIN 1671

MAGNETOHYDRODYNAMICS By Prof V C A Ferraro 1672
DEVELOPMENT OF NUCLEAR POWER By R Brightman 1673
ROCHESTER CONFERENCE ON SEMICONDUCTORS By Dr J R Tillman 1674
ENGINEERING STATICS By T M Charlton 1674
GRASSLAND MANAGEMENT By Dr W Davies 1675
HUMANE EXPERIMENTS By Prof M Weatherall 1675
U S ARMY NEUROSURGERY IN THE SECOND WORLD WAR By J E A O'Connell 1676

GAMMA-RADIATION FROM DEPOSITED FALL-OUT By D H Peirson and L Salmon 1678
SOME MEASUREMENTS OF BACKGROUND GAMMA RADIATION IN LEEDS DURING 1955–59 By Prof F W Spiers 1680
ADDITIONS TO THE BRITISH MUSEUM (NATURAL HISTORY) By Sir Gavin de Beer, F R S 1682

OBITUARIES
- DR D O MORGAN By Dr E J L Soulsby 1684
- MR WILLIAM DALLIMORE, I S O, V M H By Dr F N Howes 1684
- MR A W SIDDONS By W J Langford 1684

NEWS AND VIEWS 1685

INTERNATIONAL SYMPOSIUM ON MACROMOLECULES, WIESBADEN By Dr L Valentine 1689
INDUSTRY AND THE TECHNICAL COLLEGES IN BRITAIN 1690
MODERN NETWORK THEORY IN ELECTRICAL ENGINEERING By J T Allanson 1691
BRITISH OVERSEAS INFORMATION SERVICES 1692
METALLOGENIC MAPS By Prof S I Tomkeieff 1693
ULTRASONICALLY DISPERSED SODIUM By M W T Pratt and R Helsby 1694
SWELLING FORCES IN STRAINING CLAYS By E L Greacen 1695
A SPECIFIC RESPONSE IN THE HIPPOCAMPUS OF THE RABBIT TO OLFACTORY STIMULATION By B G Cragg 1697
ACCUMULATION OF RADIOACTIVE IODINE IN THYROID GLANDS SUBSEQUENT TO NUCLEAR WEAPON TESTS AND THE ACCIDENT AT WINDSCALE By Dr Hamish A Robertson and Ian R Falconer 1699
FORMATION OF DIFFERENT CELL–VIRUS RELATIONSHIPS IN TUMOUR CELLS INDUCED BY POLYOMA By Dr Leo Sachs and Ernest Winocour 1702
EXPERIMENTAL DEMONSTRATION OF AN INTERNAL RHYTHM OF REPRODUCTION IN A TRANS-EQUATORIAL MIGRANT (THE SHORT-TAILED SHEARWATER *Puffinus tenuirostris*) By Dr A J Marshall and Dr D L Serventy 1704

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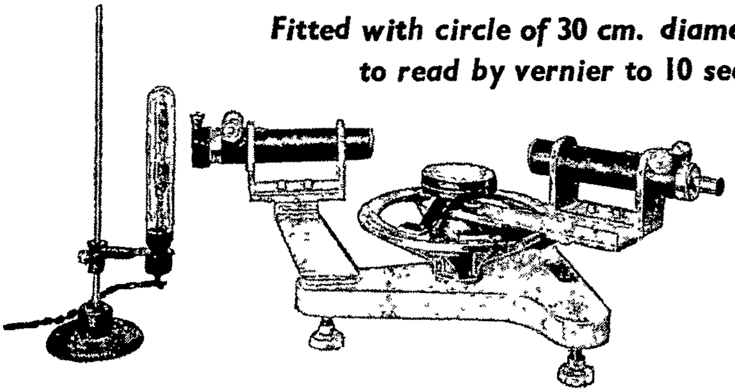

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NATURE

No 4701 SATURDAY, DECEMBER 5, 1959 Vol. 184

CONTENTS

Page

Future of Broadcasting and Television 1747

Science Writing By A L Bacharach 1749
Newtonian Documents By Dr M A Hoskin 1750
A Religion of Man? By Dr D J McCracken 1751
Husserliana Completed By F I G Rawlins 1751
Substance and Shadow By Prof R V Jones, C B , C B E 1752
Aspects of Solid State Physics By Prof E C Stoner, F R S . 1753
Music and Electronic Computors By Prof E G Richardson 1754
Semiconductors By Dr R A Hyman . 1754
International Conference of Radio Astronomers By Dr H P Palmer 1755
Modern Inorganic Chemistry By Dr D W A Sharp 1756
Classical Chemical Analysis By Dr William I Stephen 1756
Ion Exchange By D Reichenberg 1757
Geochemical Research in the United States By Dr S R Nockolds 1757
Heterocyclic Chemistry By Dr F G Mann, F R S 1758
Enzymes By Dr Edwin C Webb . 1759
Hutchinson's 'Families' By Prof. T G Tutin 1759
Coconuts By Prof C W Wardlaw . . . 1760
Hormones in Crustaceans By Prof J H Welsh 1761
Renaissance Anatomy By Dr A R Hall . 1761
Evolution of Behaviour By Dr W H Thorpe, F R S . 1762
Linear Operations and Classical Analysis By Prof L S Goddard 1763
Mathematics and Operations Research By Prof L S Goddard 1763
Mechanical Impedance Methods in Vibration By Prof R E D Bishop 1764
Friction in Textiles 1765
Advancements in Metallurgy By Prof F C Thompson 1765
Nuclear Energy and Medicine By Dr N M Blackett 1766
Derbyshire Place-Names By I S Maxwell 1767

A Physical Basis for Land Use Policy in Tropical Catchment Areas By Dr H C Pereira 1768
Fractionation Phenomena in Nuclear Weapons Debris By K Edvarson, Kerstin Low and J Sisefsky 1771
A New Service for Naturalists By R S R Fitter 1774

News and Views 1775

Progress in Coke Research in Great Britain 1778
Soil Salinity Course in Tunisia By Prof W R van Wijk 1778
The National Chemical Laboratory By Prof J R Partington 1779
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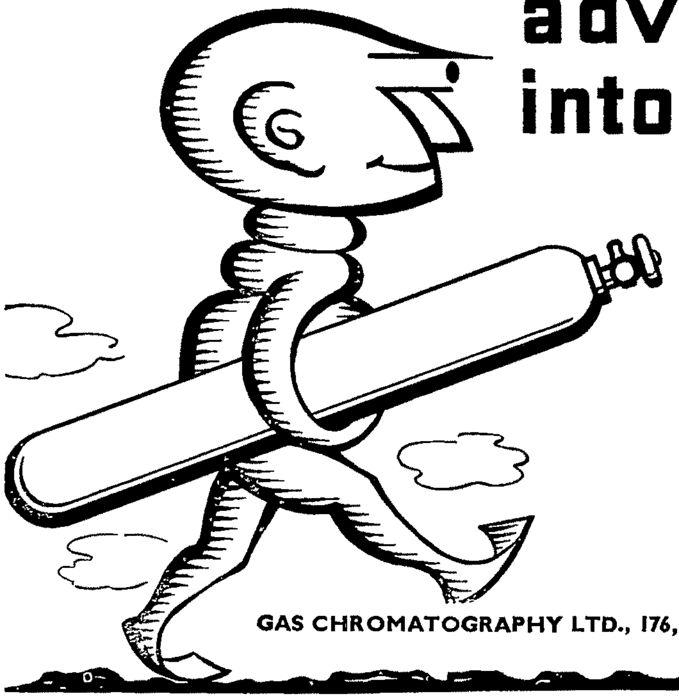

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NATURE

No 4702 SATURDAY, DECEMBER 12, 1959 Vol 184

CONTENTS

Page
Application of Science in Industry 1827

The History of Western Thought By Gerd Buchdahl 1829
A History of Iron and Steel in China By Prof F C Thompson 1830
Use of Isotopes in Organic Syntheses By Dr G Eglinton . 1830
Pharmaceutical Research in the U S S R By Dr D Train . 1831

The Royal Society By Sir Cyril Hinshelwood, P R S 1833
The Shape of Protein Molecules suggested by Electron Microscopy By Dr R C Valentine 1838

Obituary

Prof C T R Wilson, C H , F R S By Prof Norman Feather, F R S 1842

News and Views 1843

The British Cotton Industry Research Association 1846
Agricultural Institute of the Republic of Ireland 1847
Electrophoresis of Human Gastric Juice By Dr Ragnhild Gullberg and Dr Borje Olhagen 1848
Ecology of Acraniate Larvæ By J H Wickstead and Quentin Bone 1849
Enzymic Activities of Human Skeletal Muscle Mitochondria a Tool in Clinical Metabolic Research By Dr L Ernster, Dr D Ikkos and Dr R Luft 1851
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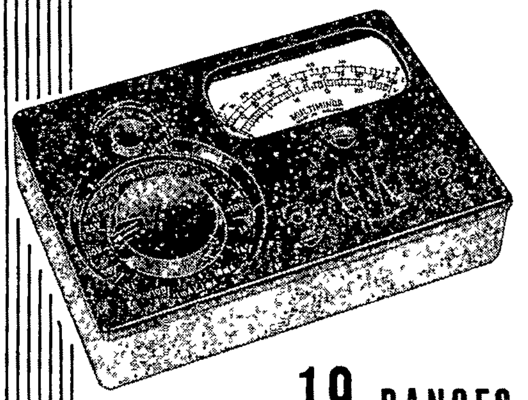

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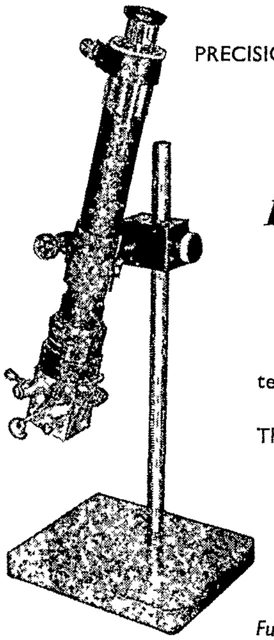

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NATURE

No 4703 SATURDAY, DECEMBER 19, 1959 Vol 184

CONTENTS

Page
Scientific Research in Great Britain 1897

A History of Magic and Experimental Science By Dr V A Eyles 1899
Old Chemistry By Prof J R Partington 1900
Properties of Liquids By Prof H C Longuet-Higgins, F R S 1901
Soils of Tanganyika By Dr R M S Perrin 1901

Genetic Bases of the Thalassæmia Diseases By Prof V M Ingram and A O W Stretton 1903
International Mineralogical Association By Prof Robert L Parker 1909
School of Physics within the University of Sydney 1911

Obituary

Dr H H Potter 1912

News and Views 1913

British Agricultural History Society By G E Fussell 1916
National Research Council of Canada 1916
Dynamic and Static Deformation of Armco Iron By H P Tardif and P Chollet 1917
✓Aggregation of an Acridine Dye on Native and Denatured Deoxyribonucleates By Dr D F Bradley and Dr G Felsenfeld 1920
Effect of Chlorpromazine upon Isolated *d*-Amino-Acid Oxidase Systems By Dr Andrew Lasslo and Anne L Meyer 1922
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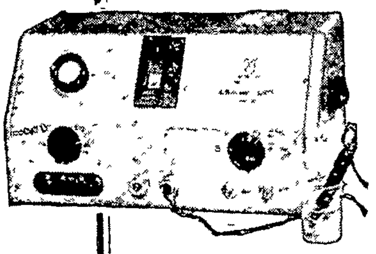

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NATURE

No 4704 SATURDAY, DECEMBER 26, 1959 Vol 184

CONTENTS

Page

SCIENTIFIC MAN-POWER PROBLEMS IN BRITAIN . 1971

MYTH AND RITUAL By Prof Norman W Porteous . . 1972
NUCLEAR TECHNOLOGY AND THE SCHOLARLY TRADITION By Dr J Walker 1973
HETEROGENEOUS CATALYSIS By Dr F S Stone . 1974
THE GENUS *Oenothera* By Dr W B Turrill, O B E , F R S . . . 1974
SCIENCE AND SCEPTICISM By Prof C K Grant . 1975
THE UNIVERSITY OF LEICESTER By Sir John Wolfenden, C B E. . 1975

IONIC PARTITION AND FINE STRUCTURE IN MUSCLE By Dr Shirley E Simon 1978
SCIENTISTS AND ENGINEERS IN BRITAIN 1982

NEWS AND VIEWS 1984

HEATING AND VENTILATION By Dr C N Davies . 1987
SELECTIVE OXIDATION OF TETRAPYRROLE SIDE-CHAINS By J Barrett and P Clezy . . 1988
HIGH PREVALENCE OF HIGH-LEVEL β-AMINO-*iso*BUTYRIC ACID EXCRETORS IN MICRONESIANS By Dr. B S Blumberg and Dr S M Gartler . . 1990
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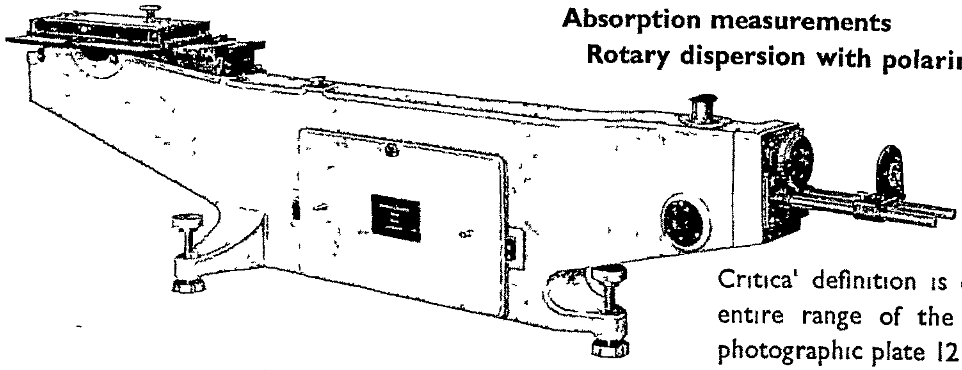

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NATIONAL PARKS AND NUCLEAR POWER STATIONS IN BRITAIN

IN addressing the Conference of National Park Authorities at Bakewell recently, then Minister of Housing and Local Government, Mr H Brooke, said that the national parks in Britain are not intended to be either museums without life in them or mere holiday resorts, and he emphasized once more the need to carry with us, in serving whatever purpose the national parks should meet, those who work and have their homes within those areas The vital necessity of public understanding and support has been clearly demonstrated during the first ten years of the operation of the National Parks and Access to the Countryside Act, but it has also been made abundantly plain that one of the major difficulties is that of finance The failure of successive Governments to provide the means has been the main cause of lack of progress, both through the impossible burden it has put on local authorities and by hindering or even preventing the work of educating public opinion

It would appear from his address to the Conference that the Minister was aware of much of this and it could be inferred from the tenor of his address that he had in mind the possibility of an amending or amplifying measure in the near future It is true he specified a clear conception of what the national parks are intended to be as a pre-condition of any fresh legislation, and it is obvious that the time is ripe for a good deal of clear and constructive thinking over this whole question of amenity, of the relation between national and local interest and the balance between various national interests which may or may not be irreconcilable

From this point of view alone, the report of the Forest of Dean Committee* merits attention This Committee was appointed in June 1955, under the chairmanship of Sir Thomas Creed, to review the situation in the Forest of Dean and, having regard to all existing rights and interests, to recommend such measures as are considered desirable and necessary to secure that the administration of the Forest, more particularly as regards the grazing of animals, may be adjusted to modern requirements The Forest of Dean is one of the ancient royal forests, second in area of woodland only to the New Forest, but although the forest does not lie in a national park area, it includes the first woodlands of the Forestry Commissioners to be designated a national forest park in England Its administration involves problems of reconciling such interests as afforestation, common grazing, and mineral and other development, which give the report of this Committee a profound interest to all concerned in the problems connected with the preservation of amenity and development generally

It is the recommendations of the report in regard to amenities, development and planning that are of chief interest here, although those relating to grazing, which occupy the greater part of the report, are of course equally important if damage either to sylviculture or features of special interest and beauty, which constitute the charm of the Forest and give it high amenity value, is to be minimized The report firmly opposes any proposal to carry out open-cast coal-working, in view of the grave effect such operations would have on the amenities of the Forest, and it will be noted that the National Coal Board on August 19 announced its intention of discontinuing such workings Likewise, the Committee recommends that the deputy surveyor, the officer responsible for the control of the Forest, should invariably be consulted when an application is made for a grant of land for mining or quarrying, or for the extension of the period of existing grants It is also recommended that the siting of overhead power lines should be planned to cause the least possible disturbance to the rural scene, and should be subject to the prior consent of the verderers

Many of the recommendations relate to matters of detail, such as the planting of the old colliery spoil heaps, the leaving of any disused railway track in a condition fit for other uses, the character of fencing and the immediate correction of such abuses of the open forest as the boiler works at Clearwell Meens (Sling) Tribute is paid to the valuable development work which has been done by the Development Association of the Forest of Dean, which should be encouraged to continue , but industrial development should be limited to that providing occupation for people who live in the immediate vicinity of the Forest and its surrounding villages and, so far as possible, should be concerned with the raw material of the Forest It is recognized that there is scope for further development of the tourist industry by providing more hotels, but the Committee recommends that the whole of the Forest should be declared an area of 'special control' under the Town and Country Planning Act, 1947, and particular attention paid to outdoor advertising. Provision of additional caravan sites and camping grounds and further facilities for car-parking and picnicing are also recommended, and the creation of additional points of view, with any necessary clearance of glades The Forest is fortunate in having soils universally recognized as favourable for the growth of the more exacting broad-leaved trees such as oak and beech, and it is recommended that the Forest should continue to be predominantly broad-leaved, and that the practice of placing tree name-boards where appropriate should be extended

The most cursory reading of the debate on national parks in the House of Lords on July 1 reveals the relevance of such details to the functioning, or even the existence, of national parks themselves, and there was a subsequent debate on nuclear power stations in the House of Commons on July 30 which was concerned specifically with the siting of overhead power lines This latter debate arose out of the decision to place a nuclear power station at Dungeness and to convey power, by overhead line or pylons, thence to Canterbury Other aspects of that decision are considered below, but the proposal to erect such overhead transmission lines from the power station to a sub-station at Lydd and to construct certain sections of an overhead transmission line from Lydd to a sub-station at Canterbury was also covered by the public inquiry on December 16–18, 1958 The Minister of Power, after consultation with the Minister of Housing and Local Government, announced on July 11 his intention to consent to the construction of the power station and of the overhead transmission lines

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* Forestry Commission Report of the Forest of Dean Committee, 1958 Pp v+59+14 plates (Cmnd 686) (London H M Stationery Office, 1959) 8s net

The reports of the inspectors in charge of both these inquiries have been published, and that relating to the power station, a proposal which was uncompromisingly opposed by the Nature Conservancy, and its approval described by the Council for Nature as a scientific tragedy, merits close study by the scientist The debate on July 30, however, is of interest for the reply it drew from Sir Ian Horobin, then Parliamentary Secretary to the Ministry of Power, first defending the Government's siting policy and then explaining further the position regarding overhead transmission The Council for Nature had suggested that the Government should now review its policy of siting power stations on coast lands, as it would be impossible to continue indefinitely the siting of such stations away from built-up areas if any stretches of coast were to be preserved unspoiled

Sir Ian advanced no fresh arguments in defence of the present policy, though it is implicit in his statement that the policy should be reconsidered as soon as practical experience has demonstrated the extreme remoteness of any possibility of accident On the question of overhead transmission, he gave figures for underground transmission as of the order of £200,000 a mile, with a further 50 per cent to cover trenching and filling-in, and another £100,000 in certain circumstances to overcome instability due to the condenser properties of the cable He did not, however, disclose the basis of this estimate of, say, £300,000 a mile, which Mr W F Deedes had challenged, and, although he assured the House that the question of design is receiving very careful attention, in view of the strong objections to overhead transmission on amenity grounds and the misrepresentations of which the electricity boards have been guilty from time to time, it would seem somewhat unreasonable not to prepare independent figures from a source the impartiality and technical standing of which are alike above suspicion It was stated by Mr Reginald Maudling in a written reply in the House of Commons on July 13 that a decision on other parts of the transmission lines had been deferred, pending the examination of a possible alternative route which the Minister of Power had requested

The debate in the House of Lords preceded the announcement of the Minister's decision, but took place a few hours after work had been started on the Trawsfynydd nuclear power station—the outstanding example so far of the approval of the erection of a major industrial undertaking in the heart of a national park The debate was primarily on the ninth annual report of the National Parks Commission, and it was notable for an outstanding speech by Lord Birkett Lord Silkin, in opening the debate, had paid tribute to the value of the voluntary work now being done in the national parks, for example, by wardens, and in clearing away disfigurements, but after commenting that the Trawsfynydd decision was actually contrary to the opinion of the Ministry's own inspector, had stressed the need for adequate financial support from national rather than local sources Lord Silkin was strongly supported in all this by Lord Birkett, who commented that the Minister of Housing and Local Government should pay much more attention to the recommendations of the Commission, and that even as little as one-eighth of a penny a week per head of the population would suffice to preserve and guard natural beauty in our parks compared with the 11*s* a week at present required for national defence

The core of Lord Birkett's speech, however, did not lie in this plea for adequate financial support and publicity or even for the placing of the financial responsibility for a national interest where it properly belongs—on national and central rather than on local funds It was rather in his reasoned argument that the National Parks Commissioners should have adequate power This is partly a matter of appropriate administrative arrangements—national and not local—though Lord Birkett insisted on the need for local support and understanding, but it is much more a matter of recognizing that there are and must be occasions when amenity is the over-riding national interest, and on this point Lord Birkett supported the proposal to establish a special committee of the Privy Council as an appeal tribunal Over the years, he urged, a body of decisions would in this way be collected which would constitute a continuing guide, and with this, and certain modifications to the National Parks Act in respect of such matters as compensation, Lord Birkett seemed to think the situation might be met satisfactorily

While welcoming these speeches, the Earl of Dundee, in his reply on behalf of the Government, did not offer an assurance of legislation or meet the argument for the over-riding interest of amenity in certain circumstances Lord Silkin, indeed, dissociated himself afterwards from Lord Birkett's proposal for an appeal tribunal, but that merely strengthens the argument for adequate authority for the National Parks Commissioners themselves. Even more than the Trawsfynydd decision, that approving the erection of a nuclear power station at Dungeness demonstrates the inadequacy of the assurance of the Earl of Dundee that the Government is conscious of its duty to preserve and enhance the beauty of national parks, and that such problems will be carefully studied

The Dungeness proposal was strongly opposed on various grounds by the Kent County Council, the Botanical Society, the Royal Society for the Protection of Birds, the Council for the Preservation of Rural England, the National Farmers' Union, the Dungeness Fishermen's Association and others , but it is the opposition of the Nature Conservancy and the Council for Nature that is of main scientific interest, and even from the national point of view is most significant The Nature Conservancy did not oppose the proposal simply on the ground that the site chosen lay within a projected nature reserve Its opposition was based much more on the unique and irreplaceable permanent importance to science of the land in question, for which there is no adequate substitute in Europe As Mr E M Nicholson, director of the Nature Conservancy, explained in his evidence at the inquiry, the area, which is probably the most important stretch of new land added to England since 1600 and is the most suitable for tracing natural processes of coast-building as well as the largest cuspate foreland in the British Isles and probably in Europe, had long been treated throughout the world as a type example of a major coastal depositional feature It combines a history of major shore changes with records of other related changes such as river outlets, ports and settlements, and provides materials for research on the relations between the emergence of dry land and the variation of the shore-line Physiographers have made comprehensive studies of this area over a prolonged period, generally involving investigations of the shingle composition of the various ridges which appear on the Foreland There is still, however, a wide divergence of views on how and why this massive deposition of shingle at Dungeness occurs The presence of a power station on the site would probably prevent the continuance of the scientific work, while the destruction of the shingle ridges would destroy the evidence from which scientists could reach their conclusions

These studies, moreover, are of practical importance to coastal engineers, and their interruption would represent a great loss to the science of coastal studies A subsequent statement issued by the Council for Nature describing the decision as a scientific tragedy went so far as to assert that one result might well be the eventual disappearance into the sea of yet more villages on the east coast of Britain through lack of adequate knowledge of the means to check erosion Mr Nicholson emphasized that the site for the power station covered practically the whole of the remaining undisturbed area of shingle and coincided with the area where the recent ridges could be dated precisely from the nineteenth and twentieth century surveys Any large-scale interference with this shingle would thus make it impossible for any further studies on the ground to link the present to the past in uninterrupted sequence, and thus destroy for all time the area of scientific value to physiographers, sterilize the follow-up of past studies and prevent future work from which important results were anticipated and for which much fundamental material existed on the Dungeness site

Besides these reasons, which were fully supported by the Council for Nature, other objections to the proposal are minor Their force was fully admitted by the inspectors in charge of the inquiry, who recognized that the shingle ridges within the power station site would be destroyed , but though they thought that the work of the bird observatory at Dungeness might also be affected, they did not think that the area would be entirely impaired as a nature reserve, or that the work of botanists and entomologists would be upset Nevertheless, with some reluctance, the inspectors in their report recommended consent to the construction of the power station, and, as already noted, the Minister of Power has now given his decision accordingly

In announcing his decision, the Minister stated that he had had in mind the growth of the demand for electricity and the great importance of implementing the nuclear power programme He also pointed out that, even if there were no nuclear power programme, it would not be practicable to site new power stations on the coalfields, because of the very large quantities of cooling water required Nevertheless, he did not meet the essential point that from a physiographical point of view the Dungeness site is unique and its loss irreparable , alternative sites for power stations do exist and will ultimately have to be found This is indeed the key issue and might well justify the decision being described as something more than a national tragedy Until it is recognized that there are places where the national interest is primarily amenity or scientific, and where power development or even defence must be secondary, neither nature conservancy, national parks nor the planning of land development can have any real meaning It is of the utmost importance that the fullest possible use should be made of such reports as those of the Forest of Dean Committee, the National Parks Commission and of the Dungeness inquiry itself They demonstrate what is really involved and the price that has to be paid if in any part of this small island natural beauty, flora and fauna, or the scientific task of understanding and utilizing the natural resources of Britain are to be safeguarded against sectional and transient interests

THE EARTH AS VIEWED IN 1959

The Earth

Its Origin, History and Physical Constitution By Sir Harold Jeffreys Fourth edition Pp xvi+420+10 plates (Cambridge At the University Press, 1959) 75*s* net

GEOPHYSICAL research has proceeded so rapidly since publication of the third edition of Jeffreys's "The Earth" in 1952 that he decided to revise it Our information and hypotheses about the universe are changing rapidly, as any reader of *Nature* knows These hypotheses provide new ideas about the origin of the Earth and, consequently, change our notions of the Earth's history Use by geophysicists of electronic computers accelerates interpretation of new results in many fields of geophysics and permits rapid checking of hypotheses. Total funds available for geophysical research, even after the International Geophysical Year, are many times more than they used to be. New conclusions, many of them about properties of the oceanic crust of the Earth, mount rapidly and many of them are making apparently well-confirmed hypotheses obsolete. We have to consider the possibility that phase changes in silicates are responsible for discontinuities in the Earth which before have been attributed to sudden changes in material. Our hypotheses concerning the source of the Earth's magnetic field are in a state of flux. It has been found that the temperature inside the Earth may be greatly affected by radiation, especially across portions of the Earth's mantle. There are other examples for the fact that, at present, many of our hypotheses concerning the Earth are changing much faster than during any earlier period. Moreover, hypotheses about new fields in geophysics, for example on the outer atmosphere, are added. As a consequence, it is now impossible for one person to be expert over the whole of geophysics, as Jeffreys points out in the preface, and he does not discuss the problems mentioned above.

This rapid progress in geophysics requires that any geophysicist who wants to be up to date must consult new books and publications. Since Jeffreys's "The Earth" is the most used and best accessible book about geophysical problems, it is very gratifying that the fourth edition has been published. Every scientist working with problems which are discussed in the book will have to familiarize himself with the new edition. Among the problems, for which Jeffreys has revised earlier discussions, are some related to non-elastic processes. Unfortunately, many of these, while playing a very important part in geophysics, are still poorly understood even by specialists. Lack of such information affects investigations of the processes connected with body tides, variation of latitude, Love's numbers for the Earth and related problems, etc. Among other sections which have been revised by Jeffreys are those related to the temperature in the Earth and the structure of the upper portion of its mantle. New results concerning both have been published since the new edition was written. The suspected wandering of the Earth's magnetic poles is mentioned in the fourth edition, but in connexion with this and the related problem of continental drift, Jeffreys has still too many doubts about the underlying processes to give details. However, his books are always inspiring, regardless of whether the reader agrees with his conclusions or not. To summarize: study of the fourth edition of "The Earth" is strongly recommended to all scientists investigating problems related to physics of the Earth.

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GEMMOLOGY

Gemstones

By G. F. Herbert Smith. Thirteenth edition, revised by F. C. Phillips. Pp. 560+27 plates. (London: Methuen and Co., Ltd., 1958.) 50*s.* net.

HERBERT SMITH'S "Gemstones" has been a standard book of reference on precious stones and a text-book for students of gemmology ever since its first edition appeared in 1912. In its ninth edition, published in 1940, it was considerably enlarged and still further additions were made to the tenth edition in 1949.

In the new edition Dr. Coles Phillips has shortened and simplified the chapters on crystal form and structure and the chapter on optical properties. Chapters on organic products—ivory, tortoise-shell, coral, jet and the resins—have been reduced and a short chapter on the formation of gemstones has been added, and also a very welcome chapter on the polarizing microscope.

An important change in the arrangement is made in that the distinction of precious and semi-precious stones is dropped. Instead of the old arrangement the principal gemstones are described in fifteen chapters and the others are collected in alphabetical order in one long chapter. This chapter contains descriptions of 25 mineral species that provide gemstones of varying merit and scarcity, including two new species discovered as gemstones, painite and taafeite, $MgBeAl_4O_8$. Sinhalite, $MgAlBO_4$, is described under olivine, with which it was confused until about 1957.

The book has been brought up to date wherever necessary and it has been possible to include a brief account of the successful crystallization of diamond in the laboratories of the General Electric Co., Schenectady, New York. Another piece of diamond news, concerning the famous Hope Diamond, was announced perhaps too late for printing in this book. This wonderful blue diamond of 44.4 carats, formerly the property of Mr. Harry Winston of New York, has now been presented by him to the Smithsonian Institution and is displayed in a special case in the newly designed mineral gallery of the National Museum in Washington.

In conclusion it should be added that print, paper and illustrations in this new edition are much improved and both author and publishers are to be congratulated.

W. CAMPBELL SMITH

TRENDS IN STATISTICS TEACHING

A First Course in Statistics

By Robert Loveday. Pp. xii+121. (Cambridge: At the University Press, 1958.) 8*s.* 6*d.*

Statistics

An Introduction. By Prof. D. A. S. Fraser. (Wiley Publications in Mathematical Statistics.) Pp. ix+398. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1958.) 54*s.* net.

THE flow of statistical text-books, which some years ago threatened to swell into a flood, has recently dwindled to a trickle; the appearance of two new books almost simultaneously is therefore a matter of some interest. But simultaneity is about the only thing these books have in common. The fact that they are aimed at different classes of students, in Mr. Loveday's case General Certificate of Education ordinary-level candidates, and in Prof. Fraser's case mathematical students in universities, accounts for only part of the difference. The main difference arises from a fundamentally different conception of what statistics is about.

Mr. Loveday is concerned throughout with distributions of empirical data and how to describe them. The concept of probability scarcely enters into the discussion; in the index, for example, the term is not even mentioned. No doubt Mr. Loveday has succeeded in presenting a clear and simple introduction to descriptive statistics Certainly he has collected together a set of exercises which will be useful in elementary teaching But it may be questioned whether, in the light of the developments of the subject that have taken place during the past thirty or forty years, this exclusive concentration on descriptive statistics is the best way of introducing the subject even at the most elementary level One would have thought that some of the time spent discussing measures of location and dispersion and similar matters could have been spared for an introduction to the more exciting topics of probability, sampling and inference

For the choice of subject-matter the author is perhaps not so much to blame as the General Certificate of Education examining authorities Mr Loveday must, however, bear the responsibility for cluttering up the student's mind with unnecessary and esoteric terms such as "ogive" in place of 'cumulative frequency distribution', "Galton graph" for 'scatter diagram', "historigram" for 'graph of a time series', "direct correlation" for 'positive correlation', and so on Those fortunate enough to become professional statisticians will never use these terms later in life Why should they have to learn them as beginners ?

It is hard to justify Mr Loveday's treatment of regression, as he confines his discussion of the fitting of regression lines to methods which are almost never employed in practice Why not give the student the formula for the least-squares coefficient ? The formula for the correlation coefficient is given in the succeeding chapter and this is certainly harder to understand, as well as to calculate, than the regression coefficient

Two minor points First, the definition of a random sample on page 93 as "one for which every member of the group has an equal chance of selection" is quite inadequate For example, a population of a hundred individuals could be divided into ten subgroups of ten in some systematic way and a sub-group picked at random, then every individual would have exactly one chance in ten of being picked but we would not have a sample of the kind the author is concerned with Secondly, the formula given for the normal distribution on page 107 should have the *n* deleted.

Prof Fraser's approach is completely different He begins with probability and probability distributions and never mentions empirical frequency distributions The question of what are the best measures of location and dispersion does not detain him at all: he plunges straight for the mean and variance and presses on at high speed Such an approach is quite intelligible in the light of modern statistical methods where the emphasis has shifted away from pure description to the fitting and testing of mathematical models Of course, in the book under review the treatment can be, and is, conducted at a fairly advanced level in view of the mathematical level of the reader for whom it is intended Nevertheless one would like to see a similar spirit abroad at all levels, however elementary

While reading the book one has the impression that among the author's guiding lights has been the wish to introduce students as early as possible to the ways of thinking about statistical problems that are customary among professional research workers It was particularly good to find a thorough treatment of orthogonal transformations, projections on to subspaces and pivotal reductions of the normal equations Once these basic ideas have been grasped the theory of multiple regression, the analysis of variance and covariance. and much else in statistical theory become straightforward

In spite of the book's merits it must be confessed that parts of it are likely to be found hard going by some students, particularly Chapter 7 on sampling from finite populations and its applications to the analysis of variance There are easier ways of deriving the formula for the variance of the mean of a sample from a finite population than that given on pages 136–7 Moreover, the misuse of the term "stratification' should not pass unmentioned Prof Fraser's "nested sampling" corresponds in sample survey terminology to multistage sampling, not to stratified sampling One feels that many of his results could be obtained more simply by current multistage theory than by the methods given in this chapter

J DURBIN

THE CULTURE OF CELLS

Cell and Tissue Culture

By Dr John Paul Pp viii+261+9 plates (Edinburgh and London E and S Livingstone, Ltd, 1959) 30*s* net.

IN 1959 it can be said that the technique of tissue culture is well established and widely applied, even on an industrial scale This claim could not have been made in 1949 Yet, more than fifty years ago the principles of cell cultivation outside the body were described and successfully demonstrated by Ross Harrison, and his work was energetically followed up by pioneer schools in the United States, Britain and elsewhere in Europe

As is strikingly apparent in Dr Paul's book, a new phase of confidence and application began about ten years ago, and cell and tissue culture to-day provides the following opportunities Mammalian and plant cells, adapted to culture conditions, can multiply indefinitely in chemically defined media When required, gram amounts of cells may be harvested after relatively short periods of growth All aspects of cell multiplication and development can be accurately determined and recorded Permanent cell strains, including a number of human origin, are available, and cultures can be sent safely to any part of the world

Clones are now readily established from single isolated cells, the chromosomes can be made clearly visible and their metabolic effects determined. Viruses may be detected and their pathogenicity investigated The metabolism of cancer cells and their response to treatment can be compared with the behaviour of normal cells, if these are freshly explanted from the body tissues

Dr Paul's up-to-date text will be invaluable to every newcomer to the technique and it will also be welcomed by experienced workers It describes lucidly all the technical aspects of the work, from the organization of a suitable laboratory (including such time-saving detail as a list of manufacturers) to the special procedures required for cell research The book is more than a laboratory manual, for it contains well-considered accounts of developments in cell research and a valuable store of references The only suggestion to be made is that future editions might include a section on the use of isotopic metabolites in tissue culture investigations

The reviewer does not wish to leave the impression that the cultivation of cells is now an easy matter and that there are no pitfalls The newcomer to the technique would be well advised to get some practical experience in an established laboratory As Dr Paul explains, his book is based to a certain extent on the instruction material of the Tissue Culture Association Summer School, which has in recent years provided a basic training for a few hundred individuals in the United States There is, as yet, no comparable scheme in Europe I Leslie

MEASUREMENT OF VALUES

The Measurement of Values

By L L Thurstone Pp. viii + 322 (Chicago University of Chicago Press , London Cambridge University Press, 1959) 56*s* 6*d* net

PROF THURSTONE, prior to his death in September 1955, was the world's greatest living psychometrist Psychologists, ever since leaving the philosophical fold, regarded the topic of values as out of bounds Most philosophers would probably be horrified at the idea of 'measuring' values In recent years, however, many scientists have realized that the concept of values is essential to science and that the greatest problem of the modern world is how to bridge the gap between technical knowledge and skill on one hand and knowledge of humanistic values on the other Some, however, regard the problem as insoluble or meaningless, forgetting that absolute laws are found neither in science nor in humanism During the last thirty years of his life Thurstone developed scientific methods which bid fair to bring social, moral and æsthetic values within the realm of experimental psychology He has ignored those interminable logical arguments concerning values

Human values are essentially subjective It was therefore necessary to establish a subjective metric, and a subjective unit of measurement which must satisfy the logical requirements of measurement as distinct from rank order This objective was reached by Thurstone by means of his law of comparative judgement which dates from 1927 Weber's law is concerned solely with physical measurements On the other hand, Fechner's law states the logarithmic relation between the subjective continuum and the physical stimulus continuum But Thurstone's law of comparative judgement is completely independent of any physical stimulus magnitudes It involves a new concept in psychophysics, namely, the discriminal error

The book has a preface by his widow, Mrs Thelma Gwinn Thurstone, herself a psychologist There is a selection of twenty-seven papers which have appeared in various journals

Part I of the book is an essay on "Psychology as a Quantitative Rational Science" where psychological concepts and strict mathematical formulation are emphasized Part II deals with "Subjective Measurement" Part III with "Attitude Measurement" Thurstone and his students were pioneers in researches on attitudes which are well known to psychologists everywhere They include such topics as prohibition, militarism–pacifism, and motion pictures

In the study of social attitudes the cognitive and the affective appraisals may be entirely independent For example, a group of people might dislike democracy but an examination might show that they did not know what they were talking about It is here pertinent to mention the views of the late Prof Flugel in his classic work on "Man, Morals and Society" (Chapters 1 and 16, 1948) where the tendency to change from orectic (moral) judgment to cognitive (psychological) judgement is one of the marks of moral progress It is true that the late Prof Reichenbach, the logical empiricist, in his "Modern Philosophy of Science" (1959) held that only a non-cognitive theory of ethics supplies an adequate explication of ethical utterances Prof Flugel, however, did not hold that orexis is supplanted by cognition Orexis still in the last resort supplies the goal at which we aim , cognition only guides us concerning the steps we must take to achieve that goal

It only remains to add that Prof Thurstone's book will long remain essential for all students of values

Ll Wynn Jones

CACTI

Die Cactaceae

Handbuch der Kakteenkunde Von Curt Backeberg Band 1 . Einleitung und Beschreibung der Peireskioideae und Opuntioideae Pp xvi + 638 + 35 tafeln 74 DM Band 2 Cereoideae (Hylocereeae—Cereeae (Austrocereinae)) Pp. xvii–xxiv + 639–1360 + 72 tafeln 87 DM (Jena . Gustav Fischer Verlag, 1958 and 1959)

THE first two volumes of this new 'handbook' to the Cactaceae provide a taxonomic treatment of the entire subfamilies Peireskioideae and Opuntioideae and reach the end of the 'subtribe' Austrocereinae of the 'semitribe' Austrocereae of the tribe Cereae, within the third and last subfamily Cereoideae In the opening key to the higher categories of the family the author recognizes a total of 220 genera, as contrasted with the 124 genera of Britton and Rose's comprehensive "Cactaceae" (1919–23) and the 41 genera of Alwin Berger's handbook to cultivated species, "Kakteen" (1929), in which *Rhipsalis*, *Cereus* and *Echinocactus* were treated in a broad sense with a large number of subgenera

Botanical exploration in South America, especially in Peru, eastern Bolivia and north-eastern Brazil, has yielded many new species to add to Britton and Rose's work, and it is good to have a new treatment with keys, descriptions and copious illustrations, some of them coloured Herr Backeberg has 57 species of *Tephrocactus*, 213 of *Opuntia*, 60 of *Rhipsalis* The elaborate system of categories in his classification of genera will not please everyone we are given, in descending order, *Unterfamilie*, *Tribus*, *Semitribus*, *Subtribus*, *Sippe*, *Untersippe*, *Gattung*, *Untergattung*, *Sektion* and *Untersektion*

The first volume begins with introductory chapters on the history of the Cactaceae in art and literature, on their uses by native tribes or in medical science, on classification, and on the maintenance of living collections In discussing cultivation, methods of grafting, etc , the author does not descend to the level of the small amateur grower, flat-dweller or floral decorator, but keeps strictly to the botanical and horticultural point of view This vast work, misnamed 'Handbuch', may well be open, like all big revisions, to much taxonomic criticism and, if only for that reason, will be indispensable to all serious students of Cactaceae N Y Sandwith

The Threshold of Space

The Proceedings of the Conference on Chemical Aeronomy, sponsored by the Geophysics Research Directorate, Air Force Cambridge Research Center, Air Research and Development Command, Cambridge, Mass , 25–28 June 1956 Edited by M Zelikoff Pp xi+342 (London and New York Pergamon Press, 1957) 105*s*

A MORE specific short title for this volume of papers on chemical aeronomy would be helpful The particular threshold of space is that of atmospheric photochemistry and spectroscopy While most of the papers are concerned with theoretical and laboratory researches, important experiments using high-altitude rockets, and some descriptions of phenomena produced by hypersonic flight, are also included

The book as a whole has both the shortcomings and the merits perhaps inevitable in a collection of individual papers There is a lack of coherence and the assumption of an extensive background knowledge by the reader However, the papers themselves, mostly by workers leading the field, are generally of a high standard Those dealing with theoretical and laboratory studies of photochemistry and spectroscopy related to the atmosphere of the earth, and of Venus, lead to accounts of rocket probing in the upper atmosphere Some of these papers relate to work such as the investigation of far ultra-violet radiation in the night sky, and the seeding of the upper atmosphere by sodium and nitric oxide which may well have heralded the opening of new branches of old disciplines

There is no doubt that both the problems and the experimental tools of hypersonic flight research will stimulate and facilitate further understanding of the physics and chemistry of the atmosphere The introduction of these aspects to the Conference proceedings is welcome Each paper is followed by a short verbatim discussion and a useful bibliography

The Insect Pests of Cotton in Tropical Africa

By E O Pearson, assisted by R C Maxwell Darling Pp x+355+8 plates (London Empire Cotton Growing Corporation and the Commonwealth Institute of Entomology, 1958) 40*s*

THIS book sets out to provide a vade-mecum for the study of the cotton pests of Africa, and is written both for "those concerned with the welfare of the cotton crop who are not entomologists" and for the field entomologist The main text occupies a little more than 300 pages of which the first fifty contain a succinct account of the cotton plant, *Gossypium*, its African environment, history, distribution and pests This section ends with an invaluable field key by means of which observed damage to the crop can be ascribed to its most likely cause, whether it be a fungus, an invertebrate or even 'big game' The rest of the book is devoted to comprehensive and critical accounts of specific pests which are grouped primarily by order, then, where convenient, by the parts of the host plant which they most usually attack This discussion is exhaustive yet always terse and gains much from the frequent and extended references to features of the environment relevant to the entomological data under discussion The authors do not hesitate to look outside Africa when they feel it will throw additional light on their subject and occasionally topics are treated almost in world-wide review The result is a satisfactory summary of current knowledge as well as a record of the authors' life-long personal experience

The book is well illustrated and indexed and is gratifyingly free from errors It may perhaps be worth noting that *Empoasca lybica* (de Bergevin) is not confined to Africa, as stated, but has been found also in Palestine, Arabia and in the Aden Protectorate, in the last of which it was reported on cotton A further natural enemy of *Empoasca facialis* Jacobi may also be added to those listed in the book, since there is in the British Museum (Natural History) collection a specimen of this leafhopper, from Serere, Uganda, which has been parasitized by a species of Dryinid W E China

Parasitic Animals

By Dr Geoffrey Lapage Pp xxiii+355 Second edition (Cambridge W Heffer and Sons, Ltd , 1958) 25*s* net

THE publication of the second edition of "Parasitic Animals" will be welcomed by many people, particularly those concerned with the teaching of parasitology Dr Lapage's treatment of his subject makes the book very readable and provides good background material for students It is, however, to be regretted that the author has not taken this opportunity to correct some of the errors of fact and to clarify some of the possibly misleading statements which appeared in the earlier edition I refer, in particular, to the perpetuation of such statements as that on p 107 that the male gametes of *Plasmodium* are "each about 15–20 mm long" and that on p 109 that the gametocytes of the same parasite "pass back from the mosquito to man they also enter man through the sucking tube and enter it passively, being unable to effect entry by their own efforts" On p 91 a slight alteration has been made to the original text but the inference to be drawn from the passage is still the same, that adult *Taenia solium* can normally develop in the intestine of the pig Reference might be made to several other points, but no doubt the observant reader will find these for himself The only major difference between the two editions is the inclusion in the second of a list of literature for further reading This is a useful addition, but it is disappointing to find that Baer's "Ecology of Animal Parasites", surely the most important book on the subject, has been omitted

C A Wright

Fundamentals of Papermaking Fibres

Transactions of the Symposium held at Cambridge, September 1957 Edited by Francis Bolam Pp x+487 (Kenley, Surrey Technical Section, British Paper and Board Makers' Association, Inc , 1958) 75*s*

THE salient features of this Symposium were summarized in *Nature*, 180, 1175 (1957) The 18 papers presented have now been published in book form, complete with illustrations, references and reports of the discussions The foreword quotes the view of Dr Otto Maas expressed in his concluding remarks at the Symposium, namely, that it had been a landmark in the science of paper making and had set a new standard for conferences in this field It is obvious that this book is indispensable to those directly interested in the subject Workers in allied fields, however, will also find in it much that is of great use and interest The inclusion of a subject index would have increased the value of the book for reference purposes Julius Grant

CYTOPLASMIC INHERITANCE

SMALL working conferences between European scientists particularly interested in genetics have been arranged from time to time, with the aid of grants from the Rockefeller Foundation to a small committee, composed of Profs M Westergaard, G Pontecorvo, B Ephrussi and D G Catcheside The fourth of these was organized by Prof B Ephrussi and held at Gif-sur-Yvette during April 3–7, 1958* On this occasion, a grant from the National Science Foundation made it possible to include five American geneticists, leaders in the study of cytoplasmic inheritance We are grateful indeed to these Foundations for the generosity which made possible such a successful and stimulating Conference

Aspects of cytoplasmic inheritance, especially in relation to development and differentiation, have been considered at two other recent conferences, one at the Royal Society[1] and the other at Gatlinburg[2] A considerable amount of the material considered at the Gif Conference has been covered in these and other publications

There are many examples of heredity which may be regarded as cytoplasmic or, more strictly, as extrachromosomal in determination, having regard to the possibility of there being intranuclear heredity which is not chromosomal Nevertheless, some expressed doubt as to whether any cytoplasmic heredity exists However, Dr R Sager, referring to the use of cytoplasmic male sterility in hybrid seed production, asserted that American geneticists had made a unique contribution to the solution of this problem Not only does cytoplasmic inheritance exist, but also it is commercially profitable and has been patented

Nevertheless, despite strong circumstantial evidence, the existence of chemical substances (plasmagenes), persisting permanently in normal cytoplasm in the same way that genes persist in the nucleus, has never been validated Indubitably, there is plenty of morphological diversity in the cytoplasm, as has been disclosed by electron microscopy Indeed, Drs W Bernhard and H K Mitchell were able to point to correlations between altered function and altered morphology

The criteria and the experimental means for the detection of extrachromosomal heredity received very careful consideration Formally, nuclear genes and plasmagenes are readily distinguishable, because in sexual reproduction nuclear genes follow precise segregational patterns based upon chromosomal mechanics while cytoplasmic genes do not The criteria of cytoplasmic heredity discussed, several or most of which have been shown to hold in many individual instances, include vegetative persistence , sudden changes in the trait (including reversibility) , absence of segregation at meiosis (therefore cannot be mapped on chromosomes) , cytoplasmic spread or infection , maternal transmission only or mainly , absence of relevant gene differences , diverse characters observed with the same nuclear genotype , character inducible by environmental agents , and selection effective during vegetative reproduction Nevertheless, these criteria are not sufficient means of recognizing cytoplasmic inheritance, *sensu stricto*, since many situations can generate this complex of symptoms

Among the numerous cases of supposed extrachromosomal inheritance there are some for which there is good evidence for extrachromosomal genetic information First among these and the most obvious are those in which microscopically visible structures in the cytoplasm are associated with the characters The chloroplast, together with the proplastid where there is a developmental sequence from the latter to the former, belongs here for one main reason When it is lost from a cell it cannot be reformed by the depleted cell It appears to be essential to have one in a cell before more can be formed This has been shown most elegantly by Deken-Grenson and Messin[3] A *Euglena* cell, descended from one treated with streptomycin to destroy its chloroplasts, can form new chloroplasts only if it still possesses at least one of these elements These experiments implicate the chloroplasts quite directly as possessing some information vital to their own reproduction

There is also evidence of mutability on the part of the chloroplasts, such as is provided by the differences shown in Renner's classical experiments However, the question is still unsettled as to whether it is the chloroplast or some other non-chromosomal component which is responsible[4] The kinetosomes and centrioles may likewise be classed here, though the evidence is less decisive The kappa, pi, mu and similar particles, rich in deoxyribonucleic acid, found in Ciliates, as well as other intracellular symbionts, are further examples, though these bodies are not normal to all or indeed to very many cells

Secondly, there is a considerable group of cases for which the evidence points to extrachromosomal sources of genetic information but for which there are no microscopically visible structures in the cytoplasm which show correlated behaviour The determinant of streptomycin resistance in *Chlamydomonas*[5] is a clear case The commercially important self sterilities in maize appear to belong here, as also do the plasmon traits studied particularly by German geneticists[4] Srb[6] has described an interesting case

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* The Conference was organized in seven sessions, following a general introduction by Prof Ephrussi

(1) Phenomena of Integration of Particles of Probably Extraneous Origin F Jacob and E Wollman on "Lysogeny and Zygotic Induction", Ph L'Heritier on "Carbon Dioxide Sensitivity in *Drosophila*", D Lewis on "Lysis in the Fungus *Coprinus lagopus*", G Magni on "Sex Ratio in *Drosophila*", A Ohanessian on "Genic Control of the *Drosophila* Virus", T M Sonneborn on "Kappa and Paramecin"

(2) Normal Cytoplasmic Components endowed with Genetic Continuity R Sager on "Extrachromosomal Heredity in Green Plants" W Bernhard on "Fine Structure of Cytoplasm"

(3) General discussion of preceding subjects H S Sharpe on "Closed and Open Systems of Extranuclear Inheritance in *Aspergillus*", H Laven on "Interracial (Geographical) Crosses in *Culex pipiens*"

(4) Cytoplasmic and Environmental Effects on Nuclear Information D L Nanney on "Mating Types in Protozoa", G Rizet and D Marcou on "Barrage and Senescence in *Podospora*", G Sermonti on "Cytoplasmic Inheritance in *Penicillium*", A M Srb on "Effects of Mutant and Normal Cytoplasms on *Neurospora* Phenotypes", J A Roper on "Acriflavine-induced Cytoplasmic Variants of *Aspergillus*"

(5) Flux Equilibria J Monod on "Inducible Permeation Factors and Cellular Memory in *Escherichia coli*", G H Beale on "Antigenic Types in *Paramecium*"

(6) Extrachromosomal Factors in the Synthesis of Respiratory Enzymes B Ephrussi on "Respiratory Deficiency in Yeast", P Slonimski on "Determination of Specificities of Respiratory Enzymes", H K Mitchell on "Biochemical and Genetic Aspects of Poky *Neurospora*", A B Pardee on "Genotypic Change and the Rate of Enzyme Induction"

(7) General discussion T M Sonneborn "Summary of the Conference",

Other participants were M Westergaard, J Scheucroun, G Pontecorvo, N Plus, D G Catcheside and G Brun in *Neurospora* which could belong here. A character SG (manifested as slow initial growth) appeared in *N. crassa* following acriflavine treatment and was inherited maternally. By repeated backcrossing, nuclei of other species could be introduced into SG cytoplasm and it was shown that a gene expressed as aconidiate in *N. sitophila* was expressed as conidiate in SG cytoplasm. Formally, one may describe this as a cytoplasmic suppressor of a nuclear gene, just the converse of the genic suppressor of poky in *Neurospora*[7]. The impressive feature is the prolonged propagation of the cytoplasmic factor unchanged, whether or not it has this particular expression. Also included here may be the general 'pattern of organization', by which the information given by the nucleus to the cytoplasm is marshalled. The cytoplasmic reproduction of enzyme specificity may be an aspect of this.

The petite mutants in the yeast[8] and the poky ones in *Neurospora*[9] surely belong to one of the above two groups, indeed to the first if mitochondria are implicated. It is interesting to note that electron microscopy of poky *Neurospora* shows slightly abnormal mitochondria in conidia, and grossly altered mitochondrial material in the hyphæ.

Thirdly, the transmission of virus or provirus is the mechanism in another group in which the inheritance can be traced to a particle by various means. The situation in lysogenic bacteria forms a model. As Jacob and Wollman[10] have shown, prophage in *E. coli* is closely integrated with the bacterial chromosome, though it is not a part of its linear structure. The presence of prophage does not alter the genetic distance between markers in its region of integration, despite that it covers a considerable part, about one-fiftieth, of the map. The phage is perhaps synapsed with the bacterial chromosome, but its material is not identical with the genetic material of the bacterium, for neither can add to the other. There are various ways in which a system with or without a virus or provirus could exhibit apparent extrachromosomal heredity.

The virus and provirus scheme applies very well to the case of sensitivity to carbon dioxide in *Drosophila*[11]. The resistant flies, free of σ virus, seem equivalent to non-lysogenic bacteria. The non-stabilized σ condition, which is not transmitted by males, would be equivalent to infected bacteria. The stabilized condition, in which males may transmit σ virus to offspring to give the unstabilized condition, would be equivalent to lysogenic bacteria, with the virus integrated, perhaps to a chromosome. Fourthly, the ρ condition, in which sensitivity develops with ageing, but only in a proportion of the flies, would correspond to defective virus. The stabilized ρ condition would be equivalent to defectively lysogenic bacteria.

It therefore appears that elements exerting a hereditary influence may be present alternatively in the nucleus, associated with a particular part of the chromosome, or free in the cytoplasm. That the elements known to behave in this way happen to be pathological could simply be a consequence of the presence and action of normal ones being undetectable. Cellular differentiation and consequent cytoplasmic inheritance in cell lines could be due to controlled movement, between nucleus and cytoplasm, of controlling elements. Indeed the liaison between nucleus and cytoplasm seems to require a system of directors, messengers and executives.

In a further class of cases, the genetic information is in the nucleus, but the different states of the cytoplasm act epistatically. Here may be placed the permease system induced in *Escherichia coli* by thiomethylgalactoside[12], the serotypes and the mating types of *Paramecium*[13]. The complete range of potentiality in the case of the *Paramecium* characters is determined by the nucleus. The individual characters, as is particularly clear in the case of the serotypes, depend for their specificity upon the genes themselves. Extrachromosomal factors intervene only in determining which of the possibilities is expressed in a given cell. The particular expression in a cell determines, subject to revolutions caused by environmental changes, what shall be expressed in its descendants. This epistasis is cytoplasmic in the case of the serotypes. In the case of the mating types it is primarily in the macronucleus, but secondarily there is transmission through the cytoplasm in *Paramecium aurelia* of group *B*[14]. The cytoplasm of a differentiated cell directs the differentiation of an undifferentiated nucleus put into it. In *Escherichia*, competence to respond to the inducer is dependent upon the nuclear genotype. Thus, in both *Paramecium* and *Escherichia* the extrachromosomal control overlies the chromosomal. Whether it has the conditional permanence of a steady-state system, or some other relatively impermanent feature of cytoplasmic architecture, or the permanence of a plasmagene, is unknown.

Many cases of apparently extrachromosomal inheritance cannot yet be classified with the least certainty with respect to probable mechanism. A few appear likely to be nuclear determined and to involve superimposed controls, namely, lysis in *Coprinus lagopus* (Lewis, D., unpublished work), certain slowly growing mutants in *Penicillium* (Sermonti, P., unpublished work), and the mycelial modifications induced in *Aspergillus* by acriflavine[15]. This leaves the barrage and senescence phenomena in *Podospora*[16], the dual phenomenon in *Aspergillus glaucus* (Sharpe[1]), the racial differences in *Culex pipiens*[17] and the sex-ratio trait in various *Drosophila* species[18]. Each of these permits of two or more different kinds of interpretation.

To some extent, recognition or denial of the existence of cytoplasmic inheritance depends upon one's definition of heredity. Some would restrict the property of being hereditary to chemical elements which persist permanently in the cytoplasm, in the same way that genes persist in the nucleus. Alternatively, it may be held that any difference in trait which is propagated under effectively the same set of conditions through vegetative or sexual reproduction, or both, is a hereditary difference. The transmission of the special property of each to its descendants constitutes heredity. This latter view regards the phenomena of development and differentiation as involving genetic changes, generally extrachromosomal, which are then maintained by a hereditary mechanism.

On this view, the difference[12] between two cultures of *Escherichia coli* growing on 10^{-5} *M* thiomethyl galactoside, one of which has been primed for a short time with 10^{-3} *M* thiomethyl galactoside and the other not, is a hereditary difference. Here the thiomethyl galactoside in higher concentration has acted as an inducer of a permease, which will then bring thiomethyl galactoside into the cell from a weaker solution unable itself to initiate the induction. Such a steady-state system would perpetuate itself under suitable conditions, without involving the self replication of particles. However, much turns upon what is meant by a particle and by self replication. There can be little doubt that permease is particulate and macromolecular in nature. The maintenance of the steady-state system in a growing culture requires a continuous supply of inducer (or substrate) in order that more permease may be produced. Somehow, between them, and of course in the environment of the living cell of which they are a part, the system of inducer and permease holds information needed to make more permease, that is, to convert or mould some other cell product to its own image. The production of this other cell product is under the control of the rest of the cell, including the genetic information of the nucleus. Thus underlying the steady-state system in this particular case is the genetic competence of the lineage of cells to respond in the particular way to the presence of the inducer.

The thiomethyl galactoside permease system has another interesting property. When the kinetics of induction are studied[19] under conditions of continuous culture, the degree of adaptedness in the culture rises linearly with time (measured as generations) if a low concentration of thiomethyl galactoside, just able to cause induction, is used. In such a culture, a proportion of the cells is fully induced or adapted, the remainder being quite unadapted. There are no intermediates, or rather the state of intermediacy is too transient to detect. Once some permease has been formed in a cell, a full complement of it is rapidly acquired, presumably according to a logistic curve. Thus the stable states are discontinuous.

Such a steady-state system has some of the attributes of genetic material, but may be thought to differ from genes and plasmagenes in certain essentials. Especially it is inherited only so long as it is expressed. Secondly, if lost it can be regenerated by a simple manipulation of the environment, provided the genetic basis is still present in the nucleus.

The contrary view is that heredity is dependent upon certain homœostatic material and that various different expressions of it, no matter how persistent, do not differ in a truly hereditary manner. Nanney[20] distinguishes these two aspects as 'genetic' and paragenetic or 'epigenetic'. As it was believed that paragenetic is etymologically unsound, 'epigenetic' was suggested, although this word is used for embryological theory and may be unacceptable for that reason. Indeed, Lederberg[2] avoids the difficulty by going to the extreme and speaking of 'nucleic' and 'epinucleic'. Nucleic information is defined as that depending upon the sequence of nucleotides in a nucleic acid, while epinucleic information is expressed as an aspect of nucleic acid configuration other than nucleotide sequence or in associated materials, such as polypeptides or polyamines. It may also reside in molecules or reaction cycles not directly connected with nucleic acid.

Whether this particular differentiation between the two levels of genetic information will stand the test of time, it is clear that the distinction is not only provocative but also the crystallization of ideas towards which many have struggled. No other biological system, short of the whole organism, approaches the properties of nucleic acid in conveying information, or equally justifies the supposition that it carries the bulk of germinal genetic information. A minor part of the genetic information, the plasmagenes, is presumably extranuclear nucleic acid. Likewise, the functionally active ribonucleic acid in the cytoplasm may carry nucleic information. Equally, if nucleic acid conserves genetic information, it is difficult to see how cellular differentiation could be determined by systematic gene mutation, that is to say, by systematic alteration of nucleotide sequences.

The epinucleic spheres of action may be extranuclear, like the steady-state systems, or nuclear, and even involve the chromosomes. There is now strong circumstantial evidence of differentiation occurring in nuclei, so that the nuclei of different tissues come to have different heritable potentialities[21]. This may be reflected in differences visible in polytene chromosomes, as in *Chironomus*[22], as well as the substitution of histone for protamine in different nuclei, but the differences could also reside in nucleoli. The local variations in behaviour of the chromosomes may sometimes be seen as intense deoxyribonucleic acid metabolism at certain regions[23]. This kind of intranuclear differentiation appears to be the basic step in the expression of mating types in *Paramecium*. Such changes could be stochastic, but it seems likely they are directed in some way not, as yet, understood. The interesting occurrence of paramutation[24] at the *R* locus in maize and the controlling elements described by McClintock[25] seem to offer models of particular systems, as also does lysogeny.

In considering cytoplasmic inheritance *sensu stricto*, we are therefore faced with the problem of distinguishing hypothetical extranuclear nucleic material from extranuclear and intranuclear epinucleic phenomena. It must be conceded that completely sufficient criteria for achieving this have not yet been recognized. It cannot yet be said whether there are macromolecules which persist permanently in the cytoplasm in the same sense as genes persist in the nucleus. Chloroplasts and mitochondria are candidates only in the same sense that the nucleus as a whole is nucleic information. The critical point would be reached if the physical bases of non-chromosomal hereditary systems, possibly nucleic or epinucleic, could be identified. In any event, whether or not we speak of epinucleic phenomena as constituting heredity, clearly they can determine the inheritance of a particular character through a considerable lineage of cells.

A complete understanding of the function of the cytoplasm in heredity is likely to involve an understanding of the nature of gene action and replication. Gene replication is generally thought to be by some kind of template mechanism, a pre-existing structure organizing smaller units to form a replica of itself. The various modifications of this basic idea need not be considered here; all would lead, theoretically, to the duplication of the gene material, most probably deoxyribonucleic acid. The heterocatalytic property of the gene, in directing functions elsewhere in the cell, may well be through the medium of replicas of itself, or of translations in a chemically different form, perhaps ribonucleic acid or protein or both. The precise activity of these will depend upon how they are integrated with the rest of the cell. If, as seems probable, they are originally filamentous, like the gene material of the chromosomes, their activity will depend upon how and where they are folded into the structure of the cell. In this respect they are likely to be influenced by the existing architecture of similar and associated units, as well as by the presence or absence of regulating substances, such as inducers or repressors. Thus, the organization for expression appears likely to involve another sort of template or mould mechanism, an architectural plan for using the unit bricks produced by the genes[26] In more specific terms, Mitchell (unpublished work) has suggested that the cytoplasmic information is carried by the proteins and that these co-operate with ribonucleic acids, carrying the information from the nucleus, in forming ribonucleoprotein templates which direct the formation of enzymes Neither system alone possesses all the information needed for the building and functioning of a cell Both involve heredity, though probably the cytoplasmic system has a lesser degree of permanency

The expression of the nuclear products has, therefore, been shown quite often to require extragenic information Knowledge of the exact nature and mode of action of the latter is highly important for understanding the functioning of the living cell While it is possible that extragenic information may be carried in a variety of ways, it may be a more economical hypothesis to suppose that it lies in one type of material capable of interacting directly with products from the nucleus In this respect, protein architecture in all its variety seems a more plausible candidate than does a system of alternative steady states, such that the functional one in the cell suppresses the action of all genes having alternative functions The latter encounters severe difficulties in view of the great variety of specific inhibitions, acting in a huge range of combinations, that would be required This is the major obstacle to interpreting, for example, the serotypes of *Paramecium aurelia* as mutually suppressive systems of steady states

D G CATCHESIDE

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THERMONUCLEAR RESEARCH IN GREAT BRITAIN

THE present state of the research programme, both theoretical and experimental, on the subject of thermonuclear fusion was the main topic at a recent two-day meeting of the Physical Society held at the Imperial College of Science and Technology, London, during September 17–18 The conference was attended by representatives from most of the major centres in Britain, and formed an interesting continuation of the meeting of wider scope at Uppsala in August It is an indication of the present high level of activity in this work that, with the exception of review papers, little duplication of material occurred

The main session was devoted to contributions outlining the research programmes at the various laboratories, universities and research institutions

Activity in Great Britain has largely centred around the toroidal pinch devices *Zeta* and *Sceptre*, where the discharge is confined by the magnetic pressure produced by the toroidal current in the discharge itself Papers by M G Rushbridge (Atomic Energy Research Establishment, Harwell) and A A Ware (Associated Electrical Industries, Ltd, Aldermaston) showed that steady progress is being made in understanding the complexities of this type of discharge In *Zeta*, experiments on the magnetic field distributions in the torus have led to a suitable choice of dimensionless parameters which can be used to characterize the discharge and compare it with various models In *Sceptre*, much effort has been put into the measurement of ion- and electron-temperatures by spectroscopic means, and the electron temperature at $2-3 \times 10^5$ °K has now been checked in several ways Similar magnetic field distributions to *Zeta* are obtained, in which the magnetic field lines within the plasma are helices of constant 'wavelength' around the torus and the mutual phase relationship of which is the same at all points This has led to a tentative explanation of the results in terms of the kind of helical instability found in some American experiments on large-size linear discharges The energy balance in these discharges is also being examined as part of a search for an explanation of the low electron temperature, but the energy losses have not yet been completely accounted for

The work of the group at the Atomic Weapons Research Establishment, Aldermaston, described by K W Allen, is in an interesting state of development The original very fast linear pinch-work which was pioneered at the Establishment is now being supplemented by an apparatus similar to the American *Scylla* at Los Alamos, which also requires a condenser bank of very low inductance In these experiments a circumferential electric current is induced in a cylindrical plasma and causes rapid compression. G B F Niblett showed some very clear streak photographs of an end-view of this compression in which it is seen to be quite a complex process with

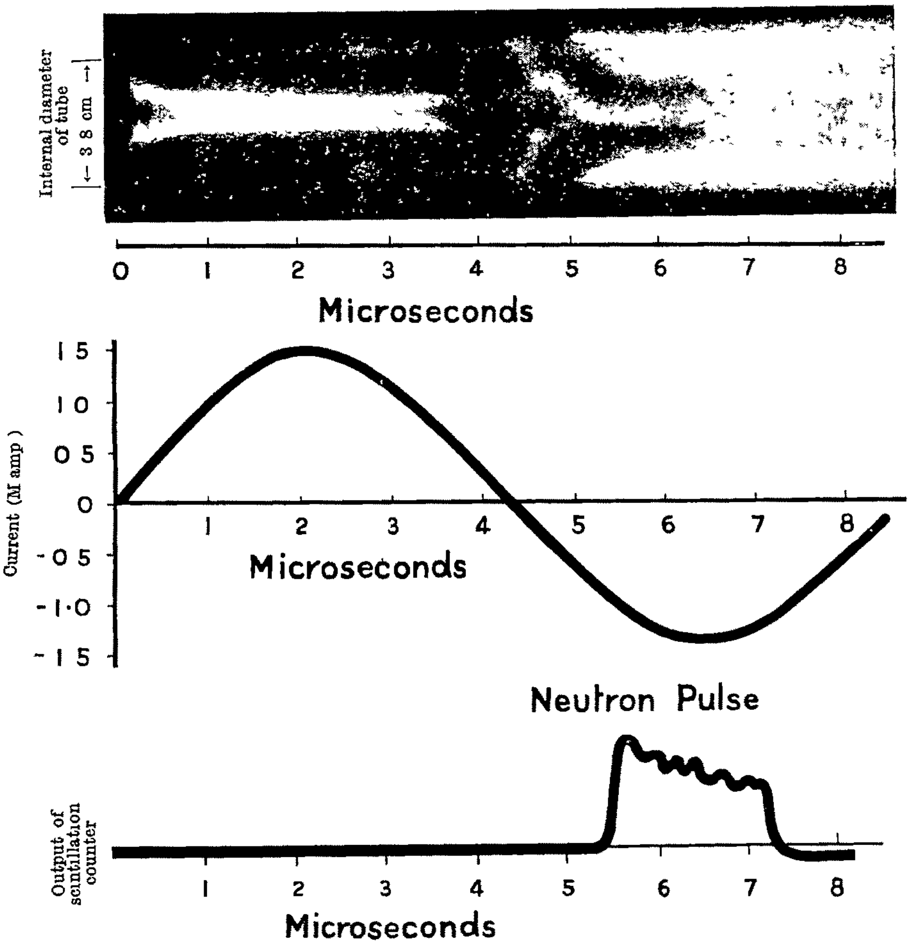

Fig. 1. Streak photograph of a discharge in deuterium with current wave-form and neutron output. (Atomic Weapons Research Establishment, Aldermaston)

marked differences between the phenomena in the first and second half-cycles (Fig. 1). The differences are ascribed to the presence of magnetic fields retained within the plasma. Neutrons are emitted, as in *Scylla*, in the second half-cycle of the discharge and the origin of these is being studied.

A further interesting possibility was mentioned which, though experimentally difficult, is now being actively considered. This is to fire a beam of fast-moving neutral atoms into the kind of magnetic bottle developed for *DCX* in America and *OGRA* in the U.S.S.R. The injection of neutral atoms instead of molecular ions should lead to better confinement, since the former can penetrate without deflexion into the centre of the apparatus before being ionized and trapped. The technical difficulties in producing such a beam must be overcome, but this can be done as an independent problem.

The work at the Imperial College of Science and Technology reported by R. Latham is based on the simplest form of linear discharge. In this the disadvantage of electrodes is compensated for by the low inductance of the tube, which is essential for rapid compression, and by the simplicity of the geometrical arrangement which allows the discharge to be viewed both from the side and the end. The first constriction, which appears as a very narrow column of high-temperature plasma (Fig. 2), the subsequent growth of instabilities (Fig. 3) and the appearance of impurities from the walls at a later stage have all been studied by means of careful photographic techniques. The use of metal liners to reduce the effect of impurities has been tried with some success.

Two papers from industrial laboratories completed the programme. P. C. McNeill, of the British Thomson-Houston Co., Ltd., Rugby, described an attempt to influence the properties of an electrical arc by placing a pair of magnetic mirrors along its length. L. A. King described work at the Electrical Research Association Laboratories, Leatherhead, where a persistent and successful attack has been made over a period of years on the thermal properties of gases as applied to the formation of cores in high-current electric arcs. The facilities at Leatherhead are now being applied to a study of the high-current vacuum arcs in use in the *DCX* machine.

The three subsequent sessions are concerned with diagnostic methods, theoretical problems and the role and use of shock waves in thermonuclear work.

In the first of these, the emphasis was on time-resolved photography and spectroscopy, which are necessary for a study of pulsed discharges of short duration. Single-shot photography with Kerr cells and image converters has been the subject of much research, and exposure times of 0·1–0·2 μsec. are now in common use. Time-resolved spectra taken at the Atomic Weapons Research Establishment by A. H. Gabriel have shown the sequence of growth and decay of lines in a linear discharge which is completed in 3–4 μsec. Such spectra are beginning to give evidence on how near these discharges are to thermodynamic equilibrium. The consequences of lack of thermodynamic equilibrium, its effect on temperature measurements and recent developments in measurement technique in the range 10,000–50,000° K. were discussed in a review paper by H. Edels (University of Liverpool).

Theoretical work on hot plasmas covers a refreshingly wide range of topics and illustrates the close connexion between plasma physics and astrophysics. It may well turn out that thermonuclear experimenting will produce ideas on phenomena in the solar atmosphere, for example, solar prominences and

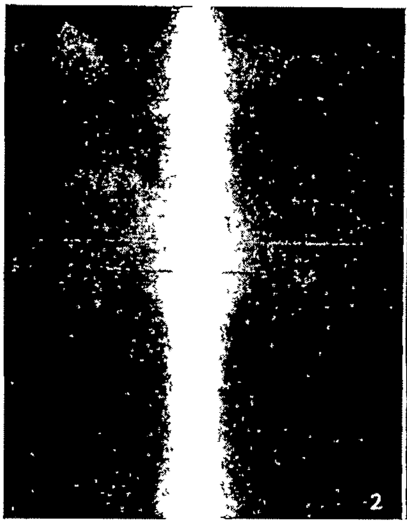

Fig 2 Side view of linear discharge taken at the time of maximum constriction (Imperial College of Science and Technology)

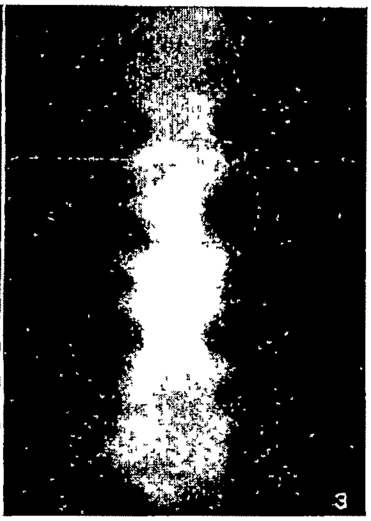

Fig 3 Side view of linear discharge showing the unstable plasma boundary (Imperial College of Science and Technology)

flares, and in a wider context on the generation of cosmic rays This is not surprising when it is remembered that a star is a naturally occurring thermonuclear reactor, and stellar atmospheres have much in common with laboratory discharges Indeed, astrophysicists have been studying thermonuclear and magneto-hydrodynamic problems for many years, long before these subjects became important in the laboratory

Problems common to astrophysics and discharge physics were discussed by Prof V C A Ferraro (Queen Mary College, London) in a contribution on current-bearing streams from the Sun, by Prof T G Cowling (University of Leeds) on mechanical effects of the interaction between a plasma and a magnetic field, and by Prof H Bondi (King's College, London) on "Magnetostatics", with the emphasis on astrophysics

Among the other theoretical papers, one by W B Thompson (Atomic Energy Research Establishment, Harwell) contained in outline a derivation of the transport coefficients of ionized plasmas which avoided the arbitrary introduction of the Debye length This was replaced by a statistical treatment of the potential fluctuations, related to the theory of electrical noise It is encouraging that the expressions previously used are in agreement with those derived by the new method A paper by M G Haines (Imperial College) considered the skin effect and showed how the familiar skin current of alternating current theory occurs only on the rising part of the wave-form of the current in a transient discharge As the current decays, the theory predicts an inverse of the skin effect with the current becoming a maximum at the centre of the discharge, and even negative at the outer surface This could in principle lead to the surface layers being violently ejected from the discharge R J Tayler (Atomic Energy Research Establishment, Harwell) has extended his stability calculations on a cylindrical discharge to include the effect of the transport coefficients He has considered a cylinder of incompressible plasma with given combinations of the coefficients of electrical conductivity and viscosity Diagrams showing the growth-rate of the $m = 0$ (sausage-like) and $m = 1$ (helical) perturbations as a function of their wave-length indicated the presence of unstable regions in both cases

The last session was on shock waves in gases These have relevance to very hot plasmas because of their use in heating the gas on one hand, and because of their appearance as a result of rapid magnetic compression on the other

In two papers, K Dolder (Atomic Energy Research Establishment) and H J Pain (Imperial College) reported on the use of shock-heated argon to find values of the non-dimensional parameter, analogous to the Lundquist number, which governs the magnitude of the interaction between a plasma and a magnetic field When plasma flows through the magnetic field of a short axial coil and interaction does occur, a characteristic pattern in the downstream gas is observed similar to that obtained with an annular constriction in the shock tube

Measurements of electrical conductivity in shock-heated argon have been made by A von Engel (Oxford) using the potential developed between two probes as the plasma moved between them in a transverse magnetic field In this case the requirement of electrical neutrality lowered the conductivity to that associated with the ions P Smy (Imperial College) reported on electrical conductivity measurements in which an azimuthal current was induced in the moving plasma as it passed through axial magnetic field coils The induced current was detected magnetically by a search coil In this instance the current flows in a closed loop in the plasma and the electronic conductivity is appropriate In both cases the results were in good agreement with the values expected theoretically

A critical account of the use of shock-wave heating as a first stage in obtaining a thermonuclear plasma was presented by J K Wright (Atomic Weapons Research Establishment, Foulness) He considered electromagnetically driven shocks and discussed

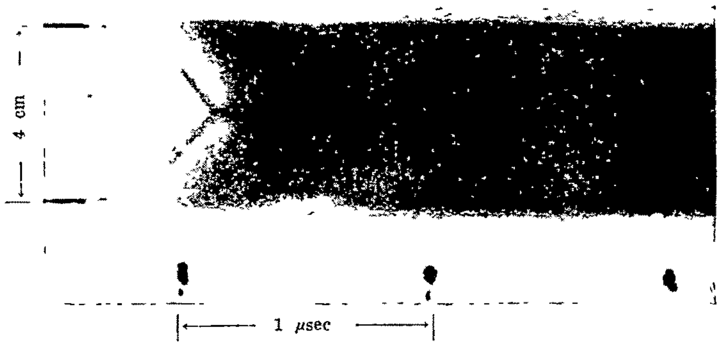

Fig 4 Streak photograph showing two colliding shock waves The shock waves move vertically and time increases from left to right (Atomic Weapons Research Establishment, Foulness)

theoretically the limits imposed by residual inductance and the requirement that the thickness of the shock-front be kept small compared with the size of the apparatus After being heated by the shock wave, the plasma was assumed to be subjected to a further stage of adiabatic compression Experiments on electromagnetically driven shocks are continuing, and an interesting streak photograph was shown of two colliding shock waves produced by this means (Fig 4) Papers were presented by D L Schultz and K C Lapworth (National Physical Laboratory, Teddington) dealing with microwave reflectivity of shock-heated plasma and with temperature determination by the method of line reversal The reflexion of shock waves from a region of high magnetic field was examined theoretically by E J Morgan (Engineering Laboratory, University of Cambridge) as a basis for future experiments

It is evident from both the Uppsala Conference and this meeting that the approach to thermonuclear research has changed since the Geneva Conference a year ago The emphasis has moved from a few projects requiring large-scale equipment to many simpler experiments designed to clarify the basic principles of plasma physics It is obvious now that in such matters as stability, plasma oscillations, energy-loss and transport processes, there is much more to be learnt The lack of immediate success of the larger machines, therefore, though disappointing is by no means without its compensations It will result in plasma physics being put on a firm basis in which the fully ionized gas will take its place with the other states of matter as leading to an accepted branch of physics This is a task for the future, and one which can be shared by many smaller groups with modest resources The outcome will undoubtedly lead to important developments of wide application both in pure science and in technology, with the generation of thermonuclear power as the final target

R LATHAM

PUGWASH INTERNATIONAL CONFERENCE OF SCIENTISTS

STATEMENT ON BIOLOGICAL AND CHEMICAL WARFARE

THE fifth in the series of Pugwash Conferences of scientists, aimed at assessing the dangers to humanity arising from developments of modern science and technology, met in Pugwash, Nova Scotia, during August 24–29, as guests of Mr Cyrus Eaton The purpose of the Conference was to assess the potentialities of chemical and biological agents as weapons, and to explore possible means for preventing their production or use in war

The subject of chemical and biological warfare has been shrouded in official secrecy For years, large projects have existed in several countries with the stated purpose of developing means of defence against such weapons We have no direct information about the results of these projects, but inevitably they increase the efficiency and destructiveness of various types of biological and chemical weapons, and result in the development of new techniques Judging from the number of technical workers involved in such projects and the money expended, much knowledge related to the production and delivery of micro-organisms for war purposes has probably been gained Moreover, unsupported statements appear which suggest that such weapons have enormous lethal or incapacitating effects against man, can destroy plants and animals, and have advantages under certain conditions of war Recently, a concerted effort appears to have been made to suggest that these weapons are more 'humane' than other means of warfare

We have discussed the general nature of such weapons as well as the properties of the individual agents and their methods of delivery, and have compared them with other weapons Our discussions suggest that the difficulties of establishing a stable and lasting peace are aggravated by the fact that all nations, whether or not they possess nuclear weapons, might produce biological and chemical weapons, international tension would consequently be increased

Potentialities of Biological and Chemical Weapons

Biological weapons—microbes, viruses and their toxic products—can be delivered and dispersed in such a way that fatal or incapacitating diseases might be produced over large areas They can be produced cheaply on a significant scale, even in a country the technological development of which is not highly advanced Such weapons could be used either alone or together with others The attack could be local or massive or could consist of individual acts of sabotage The agent could be selected to cause a great many primary casualties, or to initiate epidemics

Infective agents or toxins used as biological weapons would presumably have the following characteristics (*a*) lethal or incapacitating when applied in small amounts, (*b*) remain potent when stored or dispersed, (*c*) the diseases they produce should not be preventable by simple sanitary precautions, or by customary practices of immunization, (*d*) neither the agents themselves nor the diseases they produce should be easily identifiable, (*e*) the diseases they produce should not be curable by customary drugs or antibiotics Many well-known biological agents possess several of, or all, these attributes The simultaneous use of two or more pathogenic organisms might assist the spread of infection and confuse diagnosis

Highly virulent strains of some pathogenic agents can easily be selected, as can strains of virulent bacteria resistant to the usual antibiotics, drugs and to some disinfectants Recent advances in microbial genetics make it possible to produce variants, some of which may be even more suitable for biological warfare than naturally occurring strains

Quantitative information on the infectivity and toxicity for man of biological agents that might be used as weapons is too meagre for their effects to be compared at all accurately with those of nuclear weapons However, a surprise attack on a city might in time cause numbers of casualties approaching those caused by a small atomic bomb An attack with an infective agent, originally meant to be localized, might lead to an epidemic because of abnormal routes of delivery, the large number of primary casualties, or the disorganization of public health

The meteorological and other conditions required for biological or chemical attacks on man are so exacting that the military effects will be far from certain The necessary conditions for a successful attack might prevail only on some days and at limited times of the day, and would be subject to the errors of meteorological forecasting The discharged material, instead of moving into and staying in the intended area, might recoil on the aggressor Biological weapons would presumably be stabilized to withstand exposure to the atmosphere and so might remain active for long periods and ultimately fall anywhere

Attacks on economically useful animals are subject to many of the same limitations as attacks on man The most likely use of biological warfare on animals would be to disrupt the economy, which could be done by introducing various infections that spread very rapidly and some of which are transmissible to man

There are also agents that could be used to destroy crops, but their effects are unlikely to be important compared with attacks on human beings and animals Chemicals such as plant hormones would produce the quickest and perhaps the most serious results, but to be effective would have to be applied over great areas Some infectious diseases of plants could also be damaging, their introduction, however, could adversely affect the economy of a region for a long time, but most of them spread too slowly to influence the outcome of a war

Chemical weapons ('poison gas' or other poisonous substances) were used in the First World War and several subsequent occasions In recent years, new poisonous substances have been produced which are many times as active as the earlier agents Means for their bulk production have also been improved, as have procedures for their dissemination over areas very much larger than those covered during chemical attacks in the First World War The production of chemical warfare agents could easily be disguised as peace-time chemical industry, or such industry could be quickly converted to produce them

The so-called nerve gases, which are chemically similar to certain insecticides, are extremely potent and cheap, and cannot easily be countered with effective defensive measures Masks and appropriate clothing can partially protect against them, but it is difficult to apply such protection to large populations, and it is unlikely that nerve gas casualties could be treated with antidotes soon enough after an attack to prevent serious consequences New types of hallucinating agents or of poisons that give rise to transient mental disorganization, without recognizable permanent injury, have been advocated as means of 'humanizing' war Although they do not kill directly, their use could have serious consequences, because individuals or groups of people exposed to them behave unpredictably and often irresponsibly The extremely high level of toxicity of new types of poisonous materials, as well as the means available for their delivery, permit their effects to be compared with those of certain types of atomic weapons

Summarizing the previous paragraphs, biological and chemical agents clearly represent considerable additions to modern arsenals Yet, we realize that nuclear weapons, particularly modern hydrogen bombs, have a destructive power several orders of magnitude greater than chemical or biological weapons As means of immediate and certain destruction, these weapons cannot compare with hydrogen bombs The dependence of biological weapons on uncontrollable factors, such as meteorological conditions, and the difficulty of confining the effects to the attacked territory, make them especially unpredictable in scope and effect

World-wide apprehension about biological and chemical weapons can be allayed only by measures tending to assure that they will not be produced or used But, however difficult the international control of atomic weapons may be, the international control of biological and chemical weapons by any system of inspection seems incomparably more difficult

The first reason is that the specific weapons, or combinations of weapons, likely to be used in a particular instance cannot be foreseen

The second is that chemical or biological weapons can be selected and prepared in ordinary chemical or microbiological laboratories The fact that no elaborate or large-scale facilities are needed makes it difficult to identify possible places of preparation for biological or chemical warfare Even elaborate installations would resemble those normally used in the production of vaccines or antibiotics It follows that small and large nations, whether industrially undeveloped or highly industrialized, might secretly prepare to use such weapons, and with each added nation possessing such capabilities, the danger of war would mount

A third reason is that means of dispersal of chemical and biological agents of warfare are diverse, including aeroplanes, submarines and missiles, as well as saboteurs Their delivery, therefore, cannot be prevented because it would require a ban on all forms of transport, civil as well as military

If control by inspection is so extremely difficult, what alternative ways are there to decrease the danger that chemical and biological weapons will be used? It seems clear that international renunciation of the use of such weapons, as in the 1925 Geneva Protocol, cannot allay apprehension unless all nations, small as well as large, ratify such an agreement without reservation This is the first necessary step

Secrecy is clearly essential to preparations for biological and chemical warfare On one hand, it enables any nation planning aggression to depend upon the element of surprise, and upon the opponent's lack of effective counter-measures taken in advance On the other hand, the unknown is, of itself, a potent cause of human anxiety, and is even more so when associated with weapons of any kind Any actual danger there may be will certainly be exaggerated wherever information about any aspect of the situation is denied Secrecy on the part of possible enemies is even more productive of anxiety, suspicion and hostility, and may precipitate hostile reactions Free and frank revelation of all scientific and technical developments is essential to a degree of mutual trust necessary to resolve the acute tensions that now plague the world

The most hopeful approach to international regulation therefore seems to comprise (*a*) a general agreement to prohibit the use of such weapons, and (*b*) the renunciation of official secrecy and security controls over microbiological, toxicological, pharmaceutical and chemical–biological research

In considering how to implement the second of the foregoing proposals, we note the already excellent effects of the Report of the U N Scientific Committee on the Biological Effects of Radiation A comparable scientific committee, or a permanent U N Scientific Commission on biological and chemical modes of warfare, could help to dispel apprehension A subsidiary function of either group might be to investigate impartially the claims by plaintiff nations that others had openly or surreptitiously used methods of biological or chemical warfare against them

The very existence of such a Commission might in time arouse the conscience of the individual scientists of all nations, the only ultimate effective safeguard against violations

In agreement with the Third Pugwash Conference in Vienna, we repeat that, in the end, only the absolute prevention of war will preserve human life and civilization in the face of chemical and biological as well as nuclear weapons No ban of a single type of weapon, no agreement that leaves the general threat of war in existence, can protect mankind sufficiently We therefore must look forward to a day when the preservation of peace will transcend the ambitions of individual nations

Trust between nations cannot be established by proclamation, but only by experience, particularly by experience in co-operative work toward common aims There is already an extensive interchange of scientific information and people in the sciences basic to the problems discussed in this statement We must build on this The Commission proposed to collect and evaluate information bearing on chemical and microbiological warfare should serve not only to allay the fears of mankind that new and ever more horrible weapons of such types will be invented but also to dispel the miasma of secrecy that fosters international suspicion and tension, and in its place to extend the benevolent application of microbiological and chemical knowledge for the benefit of all men

Dr Brock Chisholm (Canada)
Prof Claude E Dolman (Canada)
Prof Donald Kerr (Canada)
Sir Robert Watson-Watt (Canada)
Dr Preben von Magnus (Denmark)
Dr Andre Lwoff (France)
Dr Pierre Thibault (France)
Dr M L Ahuja (India)
Academician Mikhail M Dubinin (Soviet Union)
Prof Alexandre A Imshenetsky (Soviet Union)
Mr Vladimir P Pavlichenko (Soviet Union)
Prof A A Smorodintsev (Soviet Union)
Prof Sven Gard (Sweden)
Mr F C Bawden (United Kingdom)
Dr Patricia J Lindop (United Kingdom)
Prof Gordon Manley (United Kingdom)
Prof Joseph Rotblat (United Kingdom)
Prof M G P Stoker (United Kingdom)
Prof H Bentley Glass (United States)
Dr Charles C Higgins (United States)
Dr Martin M Kaplan (United States)
Prof Chauncey D Leake (United States)
Prof Hugo Muench (United States)
Prof Eugene Rabinowitch (United States)
Prof Alexander Rich (United States)
Prof Theodor Rosebury (United States)

OBITUARY

Dr. B van der Pol

After a brief illness, Dr Balthasar van der Pol, a director of research in radio science, university professor and international Civil servant, died at his home in The Netherlands on October 6, at the age of seventy

Dr van der Pol was born on January 27, 1889, at Utrecht, The Netherlands, where he was educated and obtained his degree in physics at the University of Utrecht in 1916 In that year he went to study under Prof J A Fleming at University College, London He proceeded to Cambridge in the following year, where he worked in the Cavendish Laboratory as a foreign research student under Sir J J Thomson He was very interested in the Heaviside layer theory of the reflexion of radio waves, and carried out experiments designed to show that ionized air in an electric discharge could act as a radio wave reflector He was successful in this work, and on returning to Holland in 1919 he was awarded his doctor of science degree for a thesis on "High Frequency Measurements of Glow Discharges", and became assistant to Prof H A Lorentz at Teyler's Institute, Haarlem

In 1922, Dr van der Pol was appointed physicist in the research laboratory of the N V Philips works at Eindhoven, where he later became director of research in radio science He was appointed knight of the Order of Oranje Nassau in 1927, for establishing the first radio-telephone communication between the Netherlands and the Dutch East Indies Concurrently with his service in the Philips organization, he was professor of theoretical electricity in the Technical University, Delft (1938–49), and he was president of the temporary University founded at Eindhoven to replace other Netherlands universities in occupied territories, for which service he was appointed knight of the Order of the Netherlands Lion in 1946

Van der Pol was interested in a wide range of mathematical and physical subjects, and was the author of a number of papers published in scientific journals, these included two lectures delivered before the Wireless, and later Radio, Section of the Institution of Electrical Engineers in London on "Discontinuous Phenomena in Radio Communication" (*J Inst Elect Eng*, 81, 381, 1937), and "The Fundamental Principles of Frequency Modulation" (*J Inst Elect Eng*, Part III, 93, 153, 1946) He also published a book jointly with Dr H Bremmer on "Operational Calculus based on the Two-sided Laplace Integral" (Camb Univ Press, 1950) He was a member of both the American and London Mathematical Societies, of the Netherlands Royal Society, a founder member of the Netherlands Radio Society, fellow, and vice-president for 1934, of the Institute of Radio Engineers (N Y), and an honorary life-member of the Institute of Radio Engineers

(Australia). He was awarded the Medal of Honour of the Institute of Radio Engineers (N.Y.) in 1935 for contributions to circuit theory, and in 1953 the Danish Academy of Technical Sciences presented him with the Valdemar Poulsen Gold Medal for outstanding contributions in the field of radio research and for international scientific co-operation in matters related to radio communication.

Dr van der Pol became greatly interested in the scientific and technical aspects of international radio affairs and, from 1927, he was a well-known participant in a large number of conferences in all parts of the world. He was vice-president of the International Scientific Radio Union during 1934–50, and was elected an honorary president in 1952.

He was appointed the first director of the International Radio Consultative Committee in 1949, and held this position until his retirement in 1956. As the permanent executive officer of the Committee, he was the technical adviser to the International Telecommunications Union on the planning and development of radio communications during the post-war years. Until a few weeks ago, he was attending the present conference of this Union in Geneva, representing other international scientific bodies on the allocation of frequencies for radio astronomy and space research. In later years his interest in mathematics developed towards the Heaviside calculus, to the extension of which he made notable additions; he was also interested in the theory of numbers. Since his retirement in 1956, he had been an active lecturer in these subjects, particularly in the United States.

Dr van der Pol was very well liked and respected by the vast number of friends with whom he came in contact throughout the world. His qualities as a scientist and his administrative abilities as an international civil servant always received the highest recognition. He never spared himself in his devotion to the pursuit of knowledge and human understanding on a wide international basis. He was happily married and leaves a widow, a son and two daughters.

R. L. Smith-Rose

NEWS and VIEWS

Nobel Prize for Medicine for 1959

Prof. S. Ochoa

The Nobel Prize for Medicine for 1959 has been divided between Prof. S. Ochoa and Prof. A. Kornberg. Dr. S. Ochoa has long been regarded as one of the principal exponents of the highly successful enzymological approach to the study of intermediary metabolism. His recent contributions to the mechanism of the biosynthesis of nucleic acids have been preceded by a succession of outstanding biochemical discoveries principally concerned with the metabolism of carboxylic acids and with associated phosphorylation reactions. One of the most notable of these discoveries was made in 1939 while he was a research worker at Oxford. He found that large quantities of inorganic phosphate are esterified when pyruvic acid is oxidized by dispersions of brain tissue. This 'oxidative' phosphorylation is recognized as part of the fundamental mechanism whereby energy is made available from biological oxidations. With his students and colleagues at New York University, he has since discovered a number of important enzymes which are involved in the tricarboxylic acid cycle and the oxidation of fatty acids.

Dr. Ochoa's work on nucleic acids originated from experiments on phosphorylation reactions in enzyme preparations from *Azotobacter*. In 1955, together with Dr. M. Grunberg-Manago, he reported the discovery of an enzyme which is able to catalyse the removal of the terminal phosphate group from ribonucleoside diphosphates accompanied by the polymerization of the resulting nucleoside monophosphate residues. In this way, a mixture of the four appropriate nucleoside diphosphates can be converted into a polynucleotide which closely resembles naturally occurring ribonucleic acid, although it is not yet understood how the arrangement of the nucleotides in the polymer is controlled. The discovery is notable because of the structural complexity of ribonucleic acid and because of the essential functions of this material in the synthesis of proteins.

Prof. A. Kornberg

Before making their discoveries in the biosynthesis of nucleic acids, Dr. Kornberg and his colleagues were responsible for many important advances in several areas of intermediary metabolism, including the biosynthesis of nucleotides and nucleotide coenzymes. In 1956, Drs. Kornberg, Lehman, Bessman and Simms described experiments indicating that deoxyribonucleic acid could be synthesized by an enzyme system prepared from *Escherichia coli*. Further study with a purified preparation of the enzyme has shown that the nucleic acid is made from the triphosphates of the four kinds of deoxyribonucleosides and requires the presence of some pre-formed deoxyribonucleic acid. The detailed results substantiate the elegant hypothesis proposed by Drs. Watson and Crick in 1953. Thus, it seems that the double strand of the primer deoxyribonucleic acid becomes separated into its complementary single chains which then act as templates for the assembly of new polynucleotides and finally become two molecules having the detailed structure of the original double-stranded one. Within the past year, Dr. Kornberg and his very active group of research workers have reported an outstanding series of experiments on the synthesis of deoxyribonucleic acid in *E. coli* infected with certain bacterial viruses. Their experiments show that the viruses induce the infected bacteria to develop a number of enzymes which, between them, cause rapid multiplication of the deoxyribonucleic acid of the virus while preventing the formation of bacterial deoxyribonucleic acid. The great interest of these exciting developments is that deoxyribonucleic acid is a characteristic component of chromosomes and is considered to act as the principal carrier of genetic information; the sequences of the four kinds of nucleotides in the long polynucleotide chains are thought to determine the structure of the proteins and hence to control the hereditary properties of living cells.

R317

Applied Physics at Durham : Dr. D. A. Wright

IT was decided recently to set up a Department of Applied Physics in the Faculty of Applied Science within the Durham Division of the University of Durham. This is the first 'applied' department in the Durham Division and is intended to give Durham students closer contacts with industry and to contribute to the training of applied scientists. The first professor of applied physics, Dr. D. A. Wright, will take up his appointment on April 1, 1960. Dr. Wright graduated with a first-class honours degree in physics at the University of Birmingham in 1932 and later carried out research at Birmingham for which he was awarded the M.Sc. In 1955 he was awarded the degree of D.Sc. of the same University. Since 1934 Dr. Wright has been a member of the scientific staff of the research laboratories of the General Electric Company, Wembley, and is now head of the Combined Electron Physics and Solid State Physics Laboratory. His research groups have published work of high quality in the fields of thermionics and semi-conductors. Dr. Wright's recent work has been concerned with thermo-electricity, a subject which may well have considerable industrial and commercial applications. Dr. Wright has taken an active interest in the Physical Society and the Institute of Physics. He is treasurer of the Physical Society and represents it on the Parliamentary and Scientific Committee.

New Geophysical Observatory in Belgium

THE magnetic observatories founded in the nineteenth century near large cities are steadily having to be transferred to areas remote from electric transport. This happened many years ago for Kew and Greenwich. Now the Royal Belgian Meteorological Institute has had to transfer its magnetic observatory from Uccle, near Brussels, to Dourbes in south-east Belgium. The new observatory had to be sited at least 15 km. from present or potential electric transport, a requirement more difficult of fulfilment in Belgium than in the British Isles. The opportunity has been taken to build a truly magnificent comprehensive geophysical observatory, equipped for recording the terrestrial magnetic elements, earth currents, atmospheric electricity, radio atmospherics, radioactivity in the air, seismic waves, and ionospheric variations. The observatory is lavishly described with detailed descriptions of buildings and instruments, photographs (many in colours) and architectural plans in a recent publication of the Institute (Institut Royal Meteorologique de Belgique. Publications Serie A, No. 7: Réalisation du Centre de Physique du Globe à Dourbes. Par Prof. E. Lahaye. Pp. 104. Bruxelles: Institut Royale Meteorologique de Belge, 1958). This publication will be studied with great interest, and some envy, by those responsible for geophysical observatories in other countries. The detailed building plans which it contains will be invaluable in designing other new observatories or in re-designing existing ones.

Atmospheric Sciences Advisory Panel

THE U.S. National Science Foundation has announced the names of six scientists who will form the Foundation's Advisory Panel on Atmospheric Sciences. The purpose of the Panel is to provide advice to the Atmospheric Sciences Programme on the development of a programme of basic research and supporting facilities, including such fields of science as physics, engineering, oceanography, meteorology and mathematics. The Panel will consist of: Dr. Thomas F. Malone, director of research, Travelers Insurance Co., Hartford, Connecticut; Dr. Walter H. Munk, professor of geophysics, University of California at La Jolla, La Jolla, California; Dr. Walter Orr Roberts, director of the High Altitude Observatory, University of Colorado, Boulder, Colorado; Dr. Verner E. Suomi, professor of meteorology, University of Wisconsin, Madison, Wisconsin; Dr. Arthur H. Waynick, director of the Ionosphere Research Laboratory, Pennsylvania State University, University Park, Philadelphia; and Dr. E. J. Workman, president, New Mexico Institute of Mining and Technology, Socorro, New Mexico.

U.S. Expenditure on Research and Development for 1957

A PRELIMINARY report on a survey conducted by the Bureau of the Census for the National Science Foundation indicates that funds for research and development in private industry in the United States in 1957 totalled 7,200 million dollars, compared with 6,000 million dollars in 1956 (Reviews of Data on Research Development No. 14, August 1959: Funds for Research and Development Performance in American Industry, 1957. Pp. 6. Washington, D.C.: Government Printing Office). The aircraft and electrical equipment industries accounted for more than half (2,544 million dollars and 1,170 million dollars, respectively), representing increases of 21 per cent and 24 per cent on 1956 figures. Motor vehicles and other transport, and the machinery industries, were next with 708 million dollars and 688 million dollars, followed by industrial chemicals (384 million dollars), petroleum refining and extraction (230 million dollars) and communications (206 million dollars), the percentage increases over 1956 being 6, 22, 14, 23 and 16. Scientific and mechanical measuring instruments increased by 30 per cent, to 126 million dollars. Of the total of 7,200 million dollars, 3,700 million dollars came from Federal funds, which represented 85 per cent of the total in the aircraft industry and 61 per cent in the electrical industry. Expenditure on basic research totalled 241 million dollars, and of this 52 million dollars were expended by the aircraft industry, 38 million dollars by the electrical equipment industry, 30 million dollars by the petroleum refining and extraction industry, and 29 million dollars by the chemical industry. The physical and mathematical sciences claimed 54 per cent of the expenditure on basic research, engineering sciences 36 per cent and the biological sciences about 10 per cent.

The Acute Radiation Syndrome

ACCIDENTS which result in exposure of man to doses of ionizing radiation in the lethal range are sufficiently rare to be extremely important. A report by the United States Atomic Energy Commission (Report ORINS-25: The Acute Radiation Syndrome—a Medical Report on the Y-12 Accident, June 16, 1958. Compiled by Marshall Brucer. Pp. viii+188. Washington, D.C.: Office of Technical Services, Department of Commerce, 1959. 1 dollar), which follows closely to a similar one from France (Jammet, H., *et al.*, "Etude de six cas d'irradiation totale aigue accidentelle", *Rev. Franc. d'et. Clin. et Biol.*, 4, 210; 1959), therefore merits study by physicians, radiobiologists, health physicists, administrators and the daily Press It is an account of the men who were subjected to mixed neutrons and γ-rays from an unanticipated critical assembly of enriched uranium, five to doses of some 200–400 rads, three to some 30–60 rads The clinical features and progress are compared with hæmatological findings and the dosimetric estimations and calculations of the health physicists Twelve sections are contributed either by the various physicians and scientists responsible for the routine handling of the cases or by special research workers A final section is a complete appreciation by Dr Marshall Brucer, chairman of the Medical Division, Oak Ridge Institute of Nuclear Studies Dr Brucer makes the point that initially the physician is on his own The health physicist can at first classify those at risk only into three groups according to dose low (less than 250 rads), high (greater than 1,000 rads) and intermediate The first need no specific medical treatment, the second humanitarian care, but the third present problems requiring judgment The symptoms (especially vomiting and fatigue) can help the physician initially to identify the three classes The lymphocyte-count in peripheral blood is the next guide Later, particular amino-acidurias will be important, and later still the platelet-count of the blood Meanwhile, the health physicist can have reconstructed the incident, assayed the body fluids for induced radioactivity and made a more refined assessment of the doses received "A conservative rule to follow during the first few weeks is that there should be a plain and unmistakable indication for anything that is injected into the body Probably the most important feature in treating psychological upsets is to see to it that the hospital is not turned into a zoo "

Health and Industry

The annual report of the Chief Inspector of Factories on Industrial Health for 1958 is notable for two special chapters, one of which deals with occupational cancer, while the other describes a study of medical supervision in 210 factories (Ministry of Labour and National Service Pp iv+61 Cmnd 811 London H M Stationery Office, 1959 3*s* 6*d* net) The report also particularly invites members of the medical profession generally who could add to available knowledge of health hazards to report to the Medical Branch of the Inspectorate cases of interest coming to their notice in which occupational factors might be involved Such information could assist the discovery of new industrial hazards and lead to a fuller assessment of the extent and distribution of recognized industrial diseases The Industrial Health Advisory Committee, besides considering the report of a survey by the factory inspectorate on cardrooms in the cotton industry, designed to ascertain progress made in meeting exhaust ventilation requirements, appointed a sub-committee to collect and assess information as to the need for more chemical, physical and biological testing in factories with a view of reducing the risks of injury to health Although the Work in Compressed Air Special Regulations, 1958, have not been in force sufficiently long to assess their effect on the incidence of compressed air illness, progress is apparently being made and often a high standard of welfare achieved beyond the minimum standards laid down Attention is directed to the need for a careful watch for any health hazard from dust from the new 'chromizing' process of forming a surface layer of chromium over steel articles, and of aiming at complete suppression of dust or fume in the fabrication of alloys by addition of 2 per cent of beryllium to copper The chapter on occupational cancer gives a concise summary of existing knowledge that medical supervision in factories indicates that medical examination of work-people is usually regarded as the most important function of a works doctor, advice about factory conditions appear to come next, and then emergency and accident treatment and treatment for minor sickness

Study of Corrosion

The fifth report of the Corrosion Committee of the Iron and Steel Institute appeared more than twenty years ago Although no further report was published, the work has been carried on continuously, and the present sixth report which is now available deals with this (Iron and Steel Institute Sixth Report of the Corrosion Committee Compiled by Dr J C Hudson. Pp x+217 Special Report No 66 London Iron and Steel Institute, 1959 63*s*) The Committee of the Iron and Steel Institute ceased to function as such in 1946 when its work was taken over by the British Iron and Steel Research Association, and the work now published was therefore carried out under the auspices of both organizations This report consists of an extensive introduction in which the work of the Committee since 1938 is discussed as a whole This is followed by two sections dealing at length with unreported work on atmospheric corrosion in air, soil and water The final results are given of an extensive series of field tests on a wide variety of structural irons and steels carried out all over the world, and in some cases with an exposure time of up to fifteen years Section 3 of the report deals with the protection of steel against highly corrosive, humid atmospheres at temperatures up to 300° C, while Section 4 is devoted to marine corrosion and includes the results of several service trials of painting procedures and anti-corrosive compositions for ships' hulls There can be no doubt that the work published is of first-rate importance to all concerned with the preservation of structures, land and marine, against rust, and it is doubtful whether the Iron and Steel Institute has ever published a report of more far-reaching significance

Building Research in Britain

The annual report of the Building Research Board of the Department of Scientific and Industrial Research will be of interest to all who plan, design or construct buildings (The Report of the Building Research Board with the Report of the Director of Building Research Pp iv+72+12 plates London H M Stationery Office, 1959 5*s* 6*d* net) The summary of research work in hand, or recently completed, includes topics as diverse as the development of large perforated bricks, design of radiation shields, earth pressures on tunnels, supplementary artificial lighting, reinforced light-weight concrete, and rubber concreting skips The need for durability in buildings causes some investigations to extend over many years, and summaries of results obtained so far are a useful feature of the report The building industry is often accused of being the least efficient branch of engineering, and the slowest to apply the results of research, although the Building Research Station devotes much effort to making its discoveries known In order to improve the methods employed, a survey has been started of what information reaches contracting firms, and what is done with it at various levels. This investigation might well be extended to include architects, engineers and other research organizations. The inquiries and special investigations undertaken during the year reflect trends in the industry. Curtain walling systems were prominent, and interest is increasing in heating, heat and sound insulation, acoustics and lighting. The appendixes include lists of building research publications and of films on loan.

Radio Research

IN the years immediately prior to the International Geophysical Year, routine vertical incidence radio soundings of the ionosphere were carried out at about seventy stations, and during the International Geophysical Year both the number of sounding stations and the scope of the observing programmes were greatly increased. The experimental data, which such soundings provide, take the form of curves of equivalent height of reflexion (h') against frequency (f), so-called 'ionograms'. It has always been recognized that the equivalent height of reflexion of the radio waves is often quite different from the actual height of reflexion and, indeed, in the early years of radio sounding it was shown that, in general, the experimental $h'(f)$ curve could not yield unambiguously the true height/electron density profile. Furthermore, the calculation of true height is itself a matter of some complexity, especially when proper allowance is made for the influence of the magnetic field of the Earth. Hence it is, until recent years, that ionospheric workers have based their studies on parameters such as the critical frequency, the equivalent height and the 'M' factor—quantities which could be immediately read from the ionograms. However, the advent of the electronic digital computer has made possible the large-scale conversion of $h'(f)$ curves into $N(h)$ profiles, and as part of the world-wide International Geophysical Year programme a number of organizations formulated programmes for the determination of $N(h)$ profiles for representative stations and for selected observational periods. The Radio Research Special Report No. 28 prepared by Dr. J. O. Thomas and Mr. M. D. Vickers describes in detail the electronic computer programme and method adopted as part of the British International Geophysical Year ionospheric programme (Department of Scientific and Industrial Research: The Conversion of Ionospheric Virtual Height–Frequency Curves to Electron Density–Height Profiles. Pp. v+48. London: H.M. Stationery Office, 1959. 3*s*. 6*d*. net). A useful manual method for making these calculations is described in an appendix to the report and an excellent classified list of papers on this subject is also included.

Natural History in the Midlands

IN connexion with the centenary celebrations of the Birmingham Natural History and Philosophical Society in 1958, Mr. K. L. Kenrick has written an interesting and very readable account of the records of the Society and the story they tell (Pp. 52. Birmingham Natural History and Philosophical Society, 1959.). The longest of these deals with the sixteen volumes of the *Midland Naturalist*, 1878–93, including brief biographical notes on leading members of the Society, as does the section dealing with the activities of the Society between the two World Wars. After the destruction of the Society's rooms at Avebury House on October 25, 1940, activities were suspended until the end of hostilities, but the Society in 1954–55 was once more installed in the Birmingham and Midland Institute, its original home, where the Society's library, its Wynn entomological collection, the J. W. Moore collection of British butterflies and moths, a purchased entomological collection and the Archer-Overton collection of land, freshwater and marine shells are housed.

Equus przewalskii

THREE short articles by A. G. Bannikov, E. Dagva and D. Tzevegmid (*Priroda*, 5, 50; 1959) deal with the Mongolian wild horse (*Equus przewalskii*) in its native habitat and in captivity. Its present habitation area is roughly delimited by 44° N. to 46° N. and 90° E. to 95° E., a small area situated on the border between Mongolia and Sinkiang. Recently a herd of wild horses has been observed along the Takhin Shara-Nuru range, but in the opinion of observers, both the area and the number of individuals are rapidly being reduced. Drastic legislation is suggested to combat the illicit hunting of these rare animals. The effects of acclimatization of the Mongolian wild horse and the hybrids are discussed in another article by I. S. Sles (*Priroda*, 5, 53; 1959).

Spilogale Revised

VOL. 117, article 5, of the Bulletin of the American Museum of Natural History (pp. 229–392. New York, 1959. 2 dollars) is a taxonomic revision of the spotted skunks of the genus *Spilogale* by R. G. Van Gelder, assistant curator in the Department of Mammals. The spotted skunks are distributed over the greater part of the United States and Central America; they are black animals with a complex pattern of white markings which, although almost infinite in their variations, appear to be modifications of a single basic pattern of stripes. The older taxonomists regarded most of the variations as distinct species so that by 1906 Howell listed fourteen species and six subspecies. As a result of the present author's study of a long series of specimens (nearly two thousand), and particularly of local populations, this list is now mercifully reduced to two species, one *S. putorius* polytypic with fifteen subspecies, the other, *S. pygmaea*, monotypic. The characters and measurements of the different subspecies are discussed in detail and illustrated with excellent figures of colour pattern and skull form. The paper concludes with a discussion of the evolutionary trends of the genus in size, colour pattern and skull characters, and a consideration of the clines that occur in the populations of many areas. There is a full bibliography.

Female-sterile Flowers in *Fuchsia*

THE production of female-sterile flowers by hermaphrodite plants of *Fuchsia procumbens* has been described and discussed by M. Holdsworth (*Trans. Roy. Soc. New Zealand*, 86, 105 (1959)). *Fuchsia procumbens* flowers annually in late summer. The brief flowering season begins and ends with the production of a proportion of imperfect flowers—some fall without opening, others open normally but have defective styles and stigmas. Continuous long-day treatment extends the flowering season and increases the number of flowers produced throughout, but this is supposed not to be directly a day-length effect on flower initiation but on vegetative growth. Neither bud abscission nor female sterility could be shown to be simple day-length effects, but both appear to be induced primarily by low temperatures, in conjunction, perhaps, with long days in the case of abscission, and short days in the case of style abortion.

Reorganization of Root Apices after Irradiation

UNDER this title F. A. L. Clowes has described experiments in which roots were irradiated with X-rays and then fed with adenine-8-^{14}C at various intervals afterwards to observe the effect of the radiation on the sites of deoxyribonucleic acid synthesis and hence on the behaviour of the meristem (*Annals of Botany*, N.S., 23, 205 (1959)). Dividing meristem cells may be so badly damaged that they stop synthesizing deoxyribonucleic acid and dividing; and when this occurs root growth may continue by the formation of a new meristem. The latter often originates in the quiescent centre, the cells of which do not normally synthesize deoxyribonucleic acid or divide. These apparently constitute a reservoir of cells which are less vulnerable because of their quiescence; but are able to restart deoxyribonucleic acid synthesis and division when the normally meristematic cells cease to do so. Because of this re-organization of the apex, Clowes considers that it is not legitimate to argue about the behaviour of normal root meristems from chimeras induced by irradiation.

Palæotemperatures and the Origin of the Deep Sea Fauna

A CRITICAL review of the methods of determination of the temperatures of ancient seas by the measurement of the oxygen isotopes ratio in fossil calcareous organisms is given by Y. A. Birstein (*Priroda*, 5, 21; 1959). It is based partly on the work published in the Soviet Union and it leads to certain new ideas regarding the origin of the deep sea fauna. Thus the author of this review is casting doubt upon the conclusions of C. Emiliani and C. Edwards (*Nature*, **171**, 887; 1953), regarding the sharp changes of sea temperatures during the late Tertiary era, and also about those of A. Fr. Bruun (*Nature*, **177**, 1105; 1956) regarding the extinction of the deep sea fauna. According to the author all the deep oceanic regions must be considered to be regions of a relatively constant temperature, affording a place of refuge to many animal species which have eventually died out in the waters of a lesser depth.

Liquation Differentiation in Magma

A NEW contribution to one of the most controversial problems in petrology—liquation differentiation—was made by V. I. Lebedinsky (*Priroda*, 12, 99; 1958), whose original paper, which he wrote in collaboration with Mo Ke-Min, was published separately (*Bull. Acad. Sci. U.S.S.R., Ser. Géol.*, 12, 64; 1958). In these two papers the authors describe certain peculiar liparite lavas from the Kalgan region of Northern China. The lavas in question contain spherulites and spherulitic aggregates, made of a fibrous mineral. The chemical analysis of the spherulites differs from that of the ground-mass in which they are immersed by a greater amount of silica, soda and potash, and a lower amount of magnesia, lime and water. The author suggests that this rock is a solidified emulsion formed by the separation of the original magma into two immiscible liquid fractions.

A number of petrologists deny the possibility of liquation in natural magmas, although there are a number of experimental results published proving that in certain cases such a phenomenon does occur. Such are, for example, the papers by D. P. Grigoriev (1935), D. P. Grigoriev and E. V. Iskyul (1937), J. W. Greig (1927, 1928), O. F. Tuttle and I. I. Friedman (1948) and E. Roedder (1951). On the other hand, there are also numerous works dealing with spherulitic rocks and spherulites as developed in commercial glasses. Beginning with the classical studies by A. Lagorio (1887), many petrologists were attracted by this subject. A number of them, like F. Y. Loewinson-Lessing (1884, 1905, 1935) and T. L. Tanton (1925), tried to prove that certain spherulitic rocks were indeed products of magmatic liquation. On the other hand, there were many petrologists, such as, for example, D. S. Belyankin (1933, 1949), who has studied both spherulitic rocks and spherulitic commercial glasses, who do not believe in magmatic liquation, and would attribute the spherulitic structure to devitrification in the solid state.

Medicina Experimentalis

ALTHOUGH some think there are already too many scientific journals—and people !—in the world, the birth of a new one is always an interesting event. *Medicina Experimentalis* is the name which has been given to the latest arrival, to be published by S. Karger, and to be devoted to experimental medicine in its widest sense (*Medicina Experimentalis*, 1, No. 1, 1959: International Journal of Experimental Medicine. Pp. ii+68. Six numbers per volume (two volumes annually). Subscription price per volume 56 Swiss francs. Basel and New York: S. Karger, 1959). The foreword deplores the tendency of research workers "to shut themselves up hermetically in their ever narrowing specialist circles" and states that the aim of the sponsors is to provide a completely international journal which will cover the wide—and ever widening—fields of experimental physiology, pathology and therapeutics and help to bridge the gap between their multiplying specialities. Papers will be published in English, French and German and are to be limited to an overall length represented by 10,000 words. Authors will rarely be allowed to exceed this and will be charged for the excess. In return for this restriction on the verbosity of their clients, the editors promise to publish the papers submitted within three months. In these days of specialization and editorial congestion, these aims are laudable but may be rather difficult to achieve, and the small international conferences which have become so popular may be a better way of dealing with the frustrations of slow publication in parts of the world where they can be conducted successfully in a single language. The first number contains eight papers in German and one each in French and English. As the foreword says, the new journal will be what readers and authors make it. We wish it well.

Improved Gunmetals

THE Mond Nickel Co., Ltd., has announced the production of a new alloy for gunmetal: 85/6.5/3/3.5/2, copper: tin: zinc: lead: nickel. It is claimed that it has better mechanical properties at both atmospheric and elevated temperatures than 85/5/5/5 gunmetal and still retains the same adaptability to the production of pressure-tight castings. When properly made, castings in this alloy have a 0.1 per cent proof stress of around 8 tons/sq. in. with a maximum stress of 16–17 tons/sq in in sections up to 3 in thick The use of the new alloy will enable castings to be more effectively designed, as regards the use of thinner sections, and this could result in a saving of weight and, therefore, cost

New Multi-range Voltmeter

'Taylormeter Model 100*A*' is claimed by its manufacturers, Taylor Electrical Instruments, Ltd , to be the first multi-range meter in Great Britain with a sensitivity of 100,000 ohms/V d c The instrument is suitable for voltage measurements in high-resistance circuits, laboratory and research work, and in television and other electronic fields It can be used in place of a valve voltmeter but without the inconvenience of zero drift, valve replacement and alternating-current supply connexions inherent in valve voltmeters The d c current and voltage ranges are 0 2 µamp to 10 amp and 10 mV to 2,500 V (25,000 V by means of an external adaptor) The sensitivity on a c is 5,000 ohms/V and the inaccuracies on the d c , a c and ohm ranges are 2, 3 and 5 per cent, respectively Another new instrument in the Taylor multi-range universal meter series is 'Model 127*A*', which is a pocket-size meter with a sensitivity of 20,000 ohms/V d c and 1,000 ohms/V a c It is compact and inexpensive, and utilizes the new rugged Taylor moving-coil centre-pole meter and is specially ranged to give maximum reading accuracy for radio and television servicing and maintenance of electrical equipment A large scale, which is easy to read, with a 3¼ in arc, is fitted

Medical Electronics

A detailed and well-indexed bibliography on medical electronics, consisting of 2,200 references, has been prepared by the Medical Electronics Center of the Rockefeller Institute and published by the Professional Group on Medical Electronics, Institute of Radio Engineers, 1 East 79 Street, New York 21, New York (Bibliography on Medical Electronics Pp 91 2 50 dollars) The term 'medical electronics' has been taken to comprise applications of any of the branches of electronics, such as acoustics, communications, television techniques, spectrophotometry, or dielectric heating, to any problems of biological or medical research, therapy, public health and related fields The bibliography is intended to serve as source material, and though a selection has been made from all the available material, references useful both to investigators trained primarily in physics or electronics and to those engaged in biology and medicine have been included The entries are arranged in three sections, the main section consisting of references which are numbered consecutively, listed in numerical order, and grouped together in related topics , a subject index with some cross-referencing , and an author index from which anonymous and editorial matter is excluded although it is included in the previous sections

A Fossil Meteorite (?)

What may prove to be a fossil meteorite was discovered at a depth of 32 metres when excavating a mine shaft in the district of Magadan, north-eastern Siberia As described by A I Shulzhenko (*Priroda*, 5, 115 , 1959) it is an iron meteorite weighing about 15 kgm , and of a specific gravity of 7 82, and which on analyses proved to be composed mainly of iron, with 5–6½ per cent nickel and 0 4–0 5 per cent carbon

University News

Birmingham

The following appointments to lectureships have been made Dr M E Davies (in botany) , Dr C R Sladden (in biology in the Department of Zoology) , D J Blundell (in geology) , K B Haley (in engineering production) , Dr N A J Rogers (in chemistry) , P W Dykes (in medical biochemistry and experimental pathology in the Department of Experimental Pathology)

Glasgow

The report of the University of Glasgow Appointments Committee for the year ended December 31, 1958 (Pp 15 Glasgow The University 1959), records a steep rise in the number of men registered, which at 1,051 is almost double the total for 1951 This is attributed to increasing use of the Committee's services by students, a continuing upward trend in the number of older graduates seeking the advice of the appointments officers, and the increasing number who remain at the University after registering in the final year Of the total, 735 are in science and engineering, and of these, 302 registered during 1958 Of 574 male students obtaining first or second degrees in 1958, 155 were in science, 122 in engineering and 74 in other technology Of the total, 333 remained in Scotland In science, particularly chemistry, there was a proportional increase in the number entering postgraduate research In spite of the effect of the new defence policy there was no shortage of opportunity except for the less able candidates Of all honours degree candidates, 122, or 21 3 per cent, entered the teaching profession compared with 19 6 per cent in 1957, and in science the proportion rose from 21 3 to 23 8 per cent There was a further increase in the number of women registered and a slight decrease in the notifications of vacant posts, but the picture is not significantly different from that of 1957, and insufficient opportunity in Scotland for women graduates persists

Announcements

To commemorate the late Sir Francis Simon, who was Dr Lee's professor of experimental philosophy and head of the Clarendon Laboratory, Oxford, the Low Temperature Group of the Physical Society has instituted a Simon Memorial Prize This is an award to the value of £250 which is to be made at about three-yearly intervals for distinguished work in experimental or theoretical physics Dr Heinz London, of the Atomic Energy Research Establishment, Harwell, is the first recipient of this award

The third reactor school course on the Control and Instrumentation of Reactors will take place during February 1–12, 1960, and will be open to British and overseas students It will be held at Durley Hill, Bournemouth, Hampshire Further information can be obtained from the Principal, Reactor School Atomic Energy Research Establishment, Harwell, Didcot, Berkshire All application forms must be returned by December 11

Erratum In the letter entitled "Colour Centres produced by Radiation in Silica Gel", by Harold W Kohn, published in *Nature* of August 22, "50° C " in line 12, paragraph 2, column 1, p 631, should read "500° C "

DEVELOPMENT TRENDS IN AUSTRALIAN SCIENTIFIC RESEARCH

THE tenth annual report of the Commonwealth of Australia Scientific and Industrial Research Organization covers the year ended June 30, 1958 (pp 174 Canberra Government Printer, 1958 14*s*), in which the Organization expended £6,861,278 on normal research activities, £429,328 on capital works and £123,655 on grants to outside bodies Of its total income of £7,414,261, £5,792,894 was from Treasury funds and £1,267,928 from the Wool Research Trust Fund Grants to research associations totalled £41,260 and for Overseas Research Studentships £60,793 Expenditure on investigations into plant problems amounted to £754,835 , into animal health and production problems, £737,848 , into food preservation and transport, £245,125 , into forest products, £316,322 , into entomology, £215,538 , into fisheries, £171,458 , and into industrial chemistry, £624,169 £577,186 was spent on the National Standards Laboratory, £149,098 on building research, £383,672 on radiophysics research, £384,823 on wool textiles research, £175,792 on fuel research, £119,338 on the wild-life survey, and £154,929 on land research and regional survey A list of staff as well as published papers is included in the report

A representative committee appointed to consider the future development of the National Standards Laboratory found that while the Laboratory was functioning at a high level of efficiency, the staff and accommodation were too limited and future plans should include a well-planned programme of research The testing and calibration service for industry also required expansion, and in sequence with a further recommendation, Mr N A Esserman has been appointed as first director of the Laboratory Further new arrangements with the universities were concluded during the year, including the development of a Biological Inorganic Chemistry Unit in co-operation with the Australian National University, establishment of a joint electron microscopy laboratory at the University of Sydney, and of a readership in dairy husbandry, also at Sydney The design study of the proposed giant radiotelescope has been completed and the instrument is to be constructed on a site near Parkes, New South Wales Some extension of the technical liaison services of the International Wool Secretariat and its affiliated organizations was agreed and the Secretariat and the Australian Wool Bureau are co-operating in making known to clothing manufacturers throughout the world the Organization's Si-ro-set process for the permanent pleating and creasing of garments The heavy pellet developed in the Division of Biochemistry and Animal Nutrition for administering cobalt supplements to sheep has been widely adopted by graziers in Australia The work of the Organization's Plant and Soils Laboratory, Brisbane, has already established that the carrying capacity of the area of Queensland south of the Tropic of Capricorn and receiving good rainfall can be greatly increased by replacing natural pastures by sown pastures, and the work is of special interest to the beef cattle industry

The Division of Soils has developed a new section to meet the increasing demands for study in soil microscopy and its Soil Mechanics Section continued to widen its interests, especially in foundation problems in building, in pavement engineering and in the stabilization of soils Morphological and chemical data are being compiled for three representative profiles of each of the great soil groups which have been recognized in Australia It is proposed to base the main research of the Division of Plant Industry on semi-arid native grasslands at Deniliquin, New South Wales, and to use this as a centre for studies of the establishment and maintenance of sown pasture species under dry-land conditions Studies were continued on the effect of clover on the fertility of the soil and the residual effects of phosphorus, sulphur, boron and molybdenum , on the extraction from *Thiobacillus X* (Thioparus) of an enzyme and some cytochrome components which catalyse the oxidation of thiosulphate to tetrathionate , and on the effect of individual growth substances on cell division and size of fruits Experiments continued on the transfer of resistance to blue mould (*Peronospora tabacina*) from Australian species of *Nicotiana* to commercial varieties of *N tabacum* An extremely dry year was utilized to study the capacity of sown pastures to carry sheep and to persist under high rates of stocking and under different systems of utilization Studies of the effects of nitrogen supply and extension of the growing season on four strains of *P tuberosa* were completed, and an improved electron dialysis technique involving a minimum of damage to the plant tissue has been developed for determining the cation-exchange capacity of plant roots Studies continued on the beneficial effects of wilting on the ensilage of ryegrass and on the drying characteristics of pasture plants as affected by air velocity, humidity and temperature

The two irrigation research stations on which the ways in which irrigated land can be made to keep its fertility are being studied, and the techniques which can be used to reclaim waterlogged or salted soil, continued their research programmes without major change, and the Department of Agriculture, New South Wales, is co-operating in the Murrumbidgee areas in studies of control of iron chlorosis and of effects of waterlogging and salting on the nutrition of apricots and peaches The Division of Animal Health and Production has commenced work on the protozoal blood parasites which cause 'tick-fever' in cattle Good progress is being made towards an understanding of the physiological characteristics which determine heat tolerance in cattle, with a view of selecting them within the European breeds or importing them, by crossing with such breeds as the Zebu or Afrikander Diseases of sheep now receiving special attention are foot-rot and foot abscess, mycotic dermatitis and worm parasites Sheep husbandry and wool production are two of the Division's major research undertakings, with the view of understanding the genetic basis of high wool production, and the nutritional and other physiological mechanisms which enable the inherited capacity for high wool production to be manifested, reducing the heavy losses due to poor fertility and neo-natal mortality in lambs, and discovering the best and most economic means of offsetting the effects of drought by appropriate maintenance rations and husbandry The present status of animal husbandry and production investigations by Commonwealth and State organizations is under review to reveal the nature of the major problems on which attention could most usefully be focused At the Division of Biochemistry and General Nutrition's field stations experiments are being conducted on salt tolerance and supplementary feeding and on cobalt and copper deficiencies, including trials of the cobalt pellets developed to protect sheep from cobalt deficiency and phaleris staggers

No major changes are reported in the research programme of the Division of Entomology, and great stress continues to be placed on the ecological approach An officer has been appointed to study the ecology of the cattle tick in North Queensland, and work on cattle dips and pasture spelling is being intensified In systematics some progress has been made on a revision of the Calliphoridae or blowflies, and revisions of the Pyrgotidae and Acroceridae have been completed Preparation for the Commonwealth–State trial in New South Wales of a proposed method of suppressing outbreaks of the Australian plague locust advanced considerably, and in work on insect pests of stored grain the density of insect population is being studied under conditions of controlled oxygen leakage Relations between chemical structure and insecticidal activity have been examined in the volatile ketones and N-substituted amides of long-chain fatty acids

The Wildlife Survey Section intensified its study of rabbit populations and has initiated investigations of the dingo (*Canis familiaris dingo*) and the fox (*Vulpes vulpes*) Besides land surveys of the under-developed regions by the Division of Land Research and Regional Survey to determine their needs and population, the Division of Biochemistry and General Nutrition is investigating problems of plant and animal nutrition on the Coonalpyn Downs, South Australia, the Division of Animal Health and Production is breeding cattle at Belmont, Rockhampton, Queensland, and the Plant and Soil Laboratory is studying the wallum country in eastern Queensland The Division of Fisheries and Oceanography has built an experimental aquarium at Cronulla to study the behaviour patterns of commercial fish and has devised and tested a method for counting and differentiating phytoplankton at sea There was no change in emphasis of the work of the Division The Division of Food Preservation and Transport initiated, jointly with the New South Wales Department of Agriculture, a three-year investigation of levels of fruit spray residues and their removal The cheese curd fusing machine developed by the Dairy Research Section was put through successful trials and could be the first effective attempt to mechanize cheese manufacture completely Work on the biophysical properties of the giant cells of *Chara australis* was resumed, and a study of the properties of sucrose synthesized by enzymes was completed The co-operative research programmes undertaken by the Division of Building Research steadily increased during the year, including an investigation into the use of ordinary household hot-water heaters, fired by brown coal briquettes for space heating as well as water-heating to lower- and medium-priced houses

The Wool Textile Research Laboratory has developed an improved sampling device for wool and devoted greater effort to shrink-proofing, including the use of oxidizing agents Studies continued on the exchange of water between a mass of wool and the air passing through it, and work in the Division of Industrial Chemistry on the structural analysis of amino-acids has been extended to the peptides A major activity of the latter Division has been in the techniques of extractive metallurgy and a full-scale unit is to be installed for final tests on the recovery of uranium from Dyson's ore by the Weiss–Swinton jigged bed process for continuous ion exchange Also in co-operation with industry the Division has completed an investigation of the fluid bed roasting of copper concentrates and the subsequent locating and electromining of copper A process has been developed for obtaining thorium of high purity, and further kinetic studies were made on the decomposition of sulphide minerals in the presence of water and oxygen The investigation of the constituents of tar from Lurgi gasification plant continued, as well as the study of the production and properties of various kinds of defects in crystals and their bearing on chemical and physical properties of solids, while increasing effort was devoted to the design and development of optical and spectroscopic equipment An investigation on the preparation of substituted sebacic acids of possible value as plasticizers and low-temperature lubricants showed that the isomeric dihydroxysteric acid easily prepared from oleic acid, as well as erythro-dihydroxysteric acid can be converted to α-hydroxy-α-octylsebacic acid by alkali fusion and in considerably higher yields The Coal-Research Section is continuing work on the properties, composition and structure of light oils, tars and pitches produced by the carbonization of Australian coals

The Division of Tribophysics continued its fundamental studies in metal physics, surface physics and the chemistry of solids, and in some co-operative work on the refining of lead the surface properties of liquid lead have been measured in various media by a radiographic technique No new major projects were initiated in the Division of Physics, where the accuracy of the Laboratory's realization of the International Temperature Scale at high temperatures has been considerably increased, and proposals have been formulated for its extension to well below the present lower limit of −183° C, based on an investigation of the dependence on temperature of the electrical resistance of platinum Electronic apparatus designed or constructed includes a photoelectric servo system for the control of a physical balance for measuring strong magnetic fields, a nuclear resonance thermometer using the quadrupole resonance of chlorine, and the control to 1 in 10 of currents up to 10 amp in an electromagnet with a galvanometer amplifier and power transistors No major changes are reported in the work of the Division of Electrotechnology, but its high-voltage measuring facilities are to be expanded Special furnaces have been constructed and preliminary experiments made to determine the conditions of crystal growth most likely to yield satisfactory single organic crystals, while further studies have been made on the dielectric properties of polycrystalline materials and liquids Determinations of the frequency factors and energies of activation of methyl ethers and ketones confirmed that in long-chain compounds the logarithm of the frequency varies linearly with the energy of activation

The continuance of the investigations of the Division of Radiophysics into the practicability of increasing rainfall by seeding clouds with silver iodide by a further large-scale field trial is in progress in the Northern Tablelands region of New South Wales. Development continued of a method for obtaining bearings from existing Distance Measuring Equipment Beams and also research into the purification of semiconductor materials and growth of mono crystals, the transport of charges in semiconductors and the development of junction photo devices. An all-sky camera was installed in October 1957 and photographs of the whole night sky have been taken regularly at five-minute intervals since that time, recording any auroræ that may occur, and in conjunction with cameras at other stations, enabling positions and height of auroræ to be deduced. In solar physics the association between a class of radio bursts conventionally known as type II and optical features in the chromosphere has been investigated, while the main observational programme of the 15-metre wave-length "Cross" aerial was directed towards completing a survey of a belt of the sky, 10° wide, around the galactic equator. The crossed-grating interferometer is producing each day a detailed radio picture of the Sun, and observations of solar radio disturbances continued throughout the year with the Dapto radio spectrograph, which records the Sun's spectrum in the range of wave-lengths between about 1.5 and 7.5 m. The Mathematical Instruments Section completed the construction of the transistorized digital differential analyser and the techniques are being applied to the development of a small general-purpose computer.

DELAYED HYPERSENSITIVITY IN IMMUNOLOGY

THE mechanism of the delayed form of hypersensitivity, originally and still exemplified by Koch's tuberculin reaction, has proved much more difficult of analysis than that of the immediate reaction about the main immunological features of which much is now known. In the symposium on "Delayed Hypersensitivity" held by the British Society for Immunology in London on May 8, the allergic phenomena associated with reactions of this type provided the central theme for discussion.

Little progress towards the understanding of the mechanism of the tuberculin reaction can be expected, as pointed out by S. V. Boyden in opening the Symposium, until the nature of the specific change in the tissues responsible for the hypersensitivity is recognized and can be detected and measured *in vitro*. The injection of tuberculoproteins, when in soluble form, leads to the production of specific antibodies in the blood but not to the appearance of delayed hypersensitivity. Even when these proteins are adsorbed on carbon granules or red cell stromata to provide them with a particulate vehicle, their injection almost invariably results in the development of Arthus-type hypersensitivity. It seems that it is only when these antigens enter the tissues as an integral part of the bacillus, and consequently pass through some intracellular experience in phagocytes, that the animal will respond to a subsequent skin test with a typical delayed tuberculin reaction.

In part, the characteristic delay in the development of the tuberculin reaction might be attributable, as J. Pepys has observed, to the period of several hours needed for the full fixation of the provocative agent to the tissue cells. The simultaneous injection of any agent, such as histamine or hyaluronidase which can accelerate the loss of the tuberculin from the site of inoculation, or of adrenalin which can ensure its retention in the area, consequently much affects the intensity of the ensuing reaction. It follows, therefore, that any constituent present in the tuberculin preparation used that might evoke even a relatively inconspicuous immediate reaction could, by so doing, lead to the dispersal of the factor which was the cause of the delayed reaction and so mask any later manifestations of delayed hypersensitivity. On the other hand, the introduction of the tuberculin in a lipid vehicle prolongs the local retention of the tuberculin, thereby enhancing its potency and revealing in man the presence of degrees of hypersensitivity too low to be demonstrable by intracutaneous tests with large doses of tuberculin.

The discovery by Landsteiner and Chase that in guinea pigs specific delayed hypersensitivity can be transferred by an inoculum of leucocytes when one of serum is ineffective has been further analysed for human beings by H. S. Lawrence. He sought, by making extracts from such cells after their lysis, to identify the 'transfer factor' concerned. This he found to be a stable agent capable of resisting exposure to deoxyribonuclease, ribonuclease and trypsin. With Pappenheimer, he found that it may be liberated from the sensitizing leucocytes by incubation alone or by contact with tuberculoproteins; the latter procedure caused the cells themselves to lose their distinctive property of sensitizing a recipient. Delayed hypersensitivity to coccidioidin is similarly transferable with extracts of sensitizing leucocytes and the specific systemic reactivity so conferred may persist for more than a year.

In seeking some biological meaning for delayed hypersensitivity reactions, Lawrence proposed an extension of Burnet and Fenner's 'self-marker' concept to postulate that interaction between host cells and phagocytozed microbes may produce slightly altered versions of the individual's cellular components by forming intimate (self plux x) complexes. The latter, recognized as foreign by the host, may provoke a cellular immune response (transfer factor) directed against the complex. The cellular immune response takes effect against the host's own tissues in the form of a local homograft reaction wherever and whenever his cells are in appropriate combination with the antigen (x) which has induced the alteration. The effector mechanism (transfer factor) is uncovered following transfer to recipients and in the presence of the test antigen (x) it is postulated that it evokes a train of events similar to that called forth by the intact microbe in the cells of the donor.

N. A. Mitchison further followed up the possible resemblances between delayed hypersensitivity and the homograft reaction by pointing out that in both, the immunological responses appeared to be attributable to the participation of cell-bound antibody. A graft of tissue from one animal to another of the same species provokes the production of both humoral and cell-bound antibody, but the former generally does not destroy the graft Transplantation immunity thus possesses an important feature in common with delayed hypersensitivity Further similarities arise from the routes of immunization used —the intravenous injection of cells provokes only a poor response in the rabbit—as well as from the tempo of the full transplantation immunity reaction which develops before the production of humoral antibody reaches its maximum More significantly, the cellular infiltration of homografts resembles the granuloma induced by tubercle bacillary wax The nature of the cell first stimulated by the antigen may determine the type of the response, so that a single antigen may, in different circumstances, elicit either a humoral or a cell-bound antibody Alternatively, tissue cells may be supposed to possess isoantigens of different kinds each responsible for one kind of antibody

The possibility that a single molecular species of antigen can provoke simultaneously both delayed and immediate sensitivity to different determinant groups on it was discussed by P G H Gell and B Benacerraf In a study of various types of immunological reaction to proteins conjugated with such active haptenes as picryl chloride, they have demonstrated a dissociation between immediate and delayed skin reactivity to the same antigen The absence of recognizable antibodies to the protein carriers used in these conjugates, at a time when their intradermal injection proved capable of exciting a delayed skin reaction, confirms the view that reactions of this type do not depend on conventional antibodies in the circulation at this time, antibodies were present specific to the haptenic group Under other conditions, delayed sensitivity to the haptenic group was also demonstrable They questioned the view that the state of delayed hypersensitivity can be regarded as an early, perhaps immature, stage of immunity Rather, they felt that it should be considered as a distinctive response to certain qualitatively different, possibly less dominant, groups on the antigenic molecule

With the recognition of the close participation of leucocytes in the transference of specific delayed hypersensitivity, J L Gowans's account of the life-history of lymphocytes acquires particular relevance Experiments on rats have shown that the output of these cells from the thoracic duct is sufficient to replace all the lymphocytes in the blood many times daily, the production of new small lymphocytes is much lower and their survival time much longer than was formerly supposed These cells, moreover, appear to circulate freely through the tissue spaces and in this extravascular transit they may be the effector cells in immunological reactions of the delayed type

The features of the immediate and delayed 'tuberculin-type' reactions to trichophytin in guinea pigs that can be evoked either after an infection or an inoculation with the killed mycelium were described by C N Cruickshank, M D Trotter and M R Wood They found that these responses were associated with a transferable passive cutaneous anaphylaxis, but that they could occur in the absence of any detectable precipitating antibodies Chemical fractionation of the mycelium showed that the antigenic material was mainly a polysaccharide containing equal proportions of glucose and mannose Finally, R M Gordon and M Lavoipierre, in discussing immediate and delayed reactions to insect bites, pointed out that in certain instances the late reactions ordinarily attributed to the saliva of the vector may be confused with that caused by some parasite introduced into the tissues at the time

THE ELECTRIC ARC IN WELDING

FOLLOWING the practice of the previous two years, a third "Joining of Metals" Conference was held at the University of Birmingham on June 25 under the chairmanship of Prof E C Rollason, head of the Department of Industrial Metallurgy The subject on this occasion was "The Electric Arc in Welding", five papers were presented, and the conference was attended by about one hundred representatives of industry, the research associations and the universities Prof Rollason explained that the purpose of these conferences was to further the development and teaching of the basic processes underlying the practice of metal joining, and pointed out that, in arc welding in particular, much less effort had been directed towards fundamentals than to the empirical development of modern arc welding processes He then suggested that there were three ways in which the arc interacted with the metal which were of significance in welding First, there was heat transfer from the arc which was responsible for the formation of the weld pool, secondly, the chemico-metallurgical reactions taking place between the high-temperature gases in the arc atmosphere and the weld metal, and thirdly, the transfer of metal droplets across the arc which can take place against gravity and for which no satisfactory mechanism had yet been advanced

Mr D R Milner, of the Department of Industrial Metallurgy, then surveyed the present state of knowledge of those aspects of arc physics which were pertinent to these problems Throughout the main body of the arc electrical energy is utilized to heat the gas to such a temperature that it becomes thermally ionized and is thus able to provide the electrons and ions necessary to carry the required current At the anode the electron stream, and at the cathode the positive ion stream, provide the source of energy for melting the metal For low-current arcs the anode processes are reasonably well established, but less is known of conditions at the cathode However, for high-current welding systems little information is available in either case Heat and mass transfer from the arc column to the electrodes, which determines the reactions occurring between the arc atmosphere and the weld metal and controls the rate at which they take place, is dependent upon the energy dissipated, the gas properties and the mode of heat transfer Of particular interest in this respect are plasma-jets, which Maecker has demonstrated exist wherever there is a constriction in the arc, such as a cathode spot, giving rise to gas velocities of the order of 10^4 to 10^5 cm per sec

Dr G R Salter, of the Department of Industrial Metallurgy, contributed a paper which described the results of an investigation of the absorption of oxygen by titanium melted by an electric arc in an atmosphere of argon containing controlled quantities of oxygen The effect of time, oxygen partial pressure, arc length, current, electrode composition and gas flow conditions had been determined The interpretation of the results led to the conclusion that in this system the rate-controlling process was the diffusion of oxygen across a 'stagnant' boundary-layer of gas of the order of 10^{-3} cm thickness, adjacent to the molten metal, which took place over a high temperature active area where the oxygen was dissociated The magnitude of the active area was determined by the current and arc length, and the thickness of the boundary layer by the velocity of the cathode plasma-jet which impinged on the anode

Mr J B Wilkinson, also of the Department of Industrial Metallurgy, gave an account of work on heat transfer in which energy balances had been determined for arcs operating between a tungsten cathode and a water-cooled copper anode in atmospheres of argon, nitrogen, helium and hydrogen The existence of plasma-jets in these arcs had been demonstrated, their velocities estimated and attempts made to separate the heat transfer from the plasma-jet from that due to electron heating of the anode The interpretation of the measurements of the heat transferred from the plasma-jet was along similar lines to that proposed by Salter for mass transfer, that is to say, with convection transferring the heat to a boundary-layer adjacent to the metal surface Some success had been achieved by the application of a conventional non-dimensional treatment of convective heat transfer with the plasma-jet replaced by an equivalent source of hot gas emerging from a tube

In addition to their role in heat and mass transfer, plasma-jets are also responsible for the transfer of metal droplets from the molten wire electrode to the weld plate This was shown by Mr J C Needham, who described work carried out at the Electrical Research Association in which a study had been made of the detachment and flight of aluminium droplets by high-speed colour photography (8,000 frames per sec) The existence and effect of the plasma-jet could be inferred from a stream of metal vapour emanating from the droplets flowing in the direction of the jet and from the fact that the velocity of the drops continued to increase, with accelerations of $10g$ to $100g$, after they had been detached from the electrode wire, attaining terminal velocities in excess of 500 cm /sec Experimental determinations of the droplet velocity as a function of current, derived from the photographs taken by Needham, and from trajectory determinations by Mr C J Cooksey of the University of Birmingham, compared well with theoretical calculations based on a model in which the drop became detached when the force exerted on it by the plasma-jet exceeded the restraining force of surface tension, and was then freely accelerated across the arc by the impinging gas stream

An interesting characteristic of the electric arc is that if it is intensively cooled, for example, by operating it through a narrow cooled orifice, then the core temperature is increased This is because the conducting area contracts, so that which remains must have a higher degree of ionization and hence a higher temperature in order to maintain the required current Spectroscopists and arc physicists have utilized this property of the arc to heat gas to temperatures up to 50,000° C for the measurement of collision cross-sections and the transition probabilities of ionized and excited atoms and for fundamental magnetohydrodynamic studies. Mr A R Moss, of the Ministry of Supply, elaborated on the behaviour of the constricted arc and showed how it could be harnessed to technological advantage He described the various types of plasma-jet projectors and constricted arc torches developed in the Armament Research and Development Establishment, with emphasis on the design and characteristics of devices operating with a power consumption up to 100 kV amp , although much more powerful equipments were mentioned Their many potential technological applications include the melting, cutting and spraying of metallic and non-metallic materials in non-contaminating atmospheres, chemical synthesis and the production of high-temperature gas streams at hypersonic velocities

D R MILNER

INTERNATIONAL CONGRESS ON ACOUSTICS

THE third International Congress on Acoustics was held in Stuttgart during September 1–8 under the presidency of Prof Erwin Meyer

The first of the series was held in Delft in 1953 and the second in Cambridge, Massachusetts, in 1956 Already the number of participants has risen from the original 600 to more than 1,000, and in the recent congress necessitated the individual papers being read in eight concurrent sessions The mornings were devoted to review lectures, which all could attend These, and the papers presented, covered architectural acoustics, ultrasonic techniques and their applications to the study of molecular physics, acoustical properties of materials employed in industry, noise and its abatement (in particular aircraft noise), physiological and psychological acoustics

If one tries to assess the progress made since the last congress and which is likely to continue in the future, one would perhaps select the last two of these as of most interest The two reviews given on the subject of the noise of jets and the quantity of smaller papers which followed illustrated the strides which have been made since the last congress, where the subject of aeronautics interested but a few speakers The increasing noise-level to which we are subjected has stimulated more research into the functioning of the ear and the human processes of sound perception, which also brought out a stimulating array of papers

In building acoustics and molecular acoustics one has the feeling that the peak of development has passed In the former subject it seems now to be a question of fine adjustments to existing knowledge, while in the latter new developments may only be expected by going to extreme temperatures and pressures with adaptations of existing techniques. To illustrate the importance of noise in daily life and methods of measuring it, the regional authorities of Baden-Wurtemburg opened to the public an exhibit in a Stuttgart Museum entitled "Weniger Larm".

It was announced that the next international congress would be held in Copenhagen in 1962, and if the number of participants should continue to increase at the present rate this will involve the local organization in much hard thinking about how they are to lodge them and deal with the reading of the many papers expected.

This situation is not peculiar to acoustics, but there is a possibility of splitting the auditory into roughly equal numbers of those concerned with physical and physiological acoustics and those interested mainly in architectural, musical and industrial applications. Perhaps two congresses *en suite* with a week-end of social activities and excursions sandwiched between them might overcome some of the difficulties of organization.

The proceedings of the congress are to be published in book form by Elsevier Press. E. G. RICHARDSON

PHOTOGRAPHY IN THE INTERNATIONAL GEOPHYSICAL YEAR

A SYMPOSIUM on photography in the International Geophysical Year was held in Edinburgh on June 6, under the auspices of the Scientific and Technical Group of the Royal Photographic Society of Great Britain.

Following his address of welcome on behalf of the University of Edinburgh, Sir Edward Appleton stated that he believed the effect of the International Geophysical Year on association between geophysicists would be a permanent one, and recalled the descent of the recent great collaboration from earlier International Polar Years. He then described some of the ionospheric work carried out during the International Geophysical Year and directed attention to the valuable part played by photography in making possible permanent records. In conclusion, he spoke of the most striking discovery of the Van Allen radiation belt. Miss Harker, president of the Royal Photographic Society, replied and went on to discuss the wide compass of photography, illustrated by the nature of the subject of the symposium.

The study of aurorae by all-sky cameras was described by Dr. G. M. Thomas, of the Balfour Stewart Auroral Laboratory. He pointed out that remoteness and erratic occurrence make auroral data scanty, and that any casual collection of data is bad statistically. However, full-time observation is a costly matter, but sky cameras could provide the necessary supplement to visual observation. A system was described consisting of a motion picture camera viewing a large convex mirror, the mirror being heated to keep off frost and snow, and a calendar and watch placed in the field of view. Timing of the camera's function was provided by a synchronous motor. A film illustrating the systematic motion of the aurorae was shown. It is of great importance to correlate the sudden alterations which occur with changes in the magnetic field at the ground.

The next contribution reviewed some of the contributions of photographic techniques to rocket and satellite work, and described particularly the ballistic cameras developed at University College, London, for the 'grenade' experiment. This is a method of finding upper-air winds and temperatures by measuring the time of travel of sound from grenades fired from an ascending rocket. The special function of photography here is to locate the grenade bursts with great precision. When the experiment is carried out in daylight, special techniques are necessary to obtain rapid triggering of the shutters by light from the grenades. Experiments under preparation for X-ray observation of the Sun and ultra-violet astronomy of the stars were also described. The latter work is being conducted in collaboration with Dr. H. E. Butler, of the Royal Observatory, Edinburgh, who then described his use of a technique, due originally to Dr. Baker, of the same Observatory, to bring up the detail of very faint interstellar absorption lines. Basically, the problem is to bring out the signal from the 'background noise' grain in the plates, and it is accomplished by careful photometering and summing of the results from many plates, together with subtraction from a standard spectrum to remove the emission structure. The results were extremely impressive, as indeed was the amount of work required to obtain them; a million separate readings from twenty-seven different exposures were obtained.

Dr. C. J. Waddington, of the University of Bristol, described his subject as the study of the 'footprints' of cosmic ray particles. Due to the vastness of his subject, he limited his discussion to an extended series of high-altitude balloon flights with nuclear emulsions made with the avowed intention of monitoring the long-term variation of the primary cosmic radiation. Seventy-three balloon flights were made by a group led by Prof. E. P. Ney (Minnesota). A typical payload consisted of a dozen 4 in. × 4 in. 600μ Ilford G 5 emulsion plates, together with a single counter and an ion chamber. Although protons are more abundant, α-particles were chosen for the study for a variety of reasons, among which were the complications of an albedo of protons from disintegrations and the greater ease of finding and counting α-particle tracks in nuclear emulsions. The results of these observations are still being analysed, but already it is clear that differences in the variation of α-particle and proton flux after a solar flare should ultimately throw light on the properties of the space between us and the Sun.

A paper by Dr. W. I. Arvegwitch, of the U.S.S.R. Academy of Sciences Institute of Geography, was read for him in his absence. His paper discussed photo-topographic methods used by his Institute for the study of glaciers. For more than a decade glaciation has been studied by aerial photography although stereo-photogrammetric surveys from the ground are still considered to be the most reliable means of recording the state and behaviour of glaciers Recently, however, aerial photography, with its advantage of the avoidance of 'dead areas' due to obstacles, has been applied to the study of glacier dynamics Unfortunately, the paper gave no information on the experimental equipment, either aerial cameras or the new Soviet stereograph "*SD*-1", which was claimed to be notable for its precision, having a relative mean-square error of vertical control in the neighbourhood of 1/3,000 It was a conclusion of the paper that aerial photography could greatly speed up a survey, especially with the use of helicopters, but that no single method in phototopography is appropriate in every situation

The meeting ended with projection of the Russian research film, "North Pole", showing Soviet scientific research in the Arctic and describing the results of oceanographic and meteorological work Of special interest were sequences showing the circulatory movements of water and ice-flows about the Pole

R L F Boyd

GLASSHOUSE CROPS RESEARCH INSTITUTE

OPEN DAY

THE Glasshouse Crops Research Institute, Littlehampton, Sussex, held its annual open day on June 10 when nearly two hundred visitors attended The laboratories were open for inspection during the morning, and after lunch, at which the director, Mr F W Toovey, reported on the Institute's progress during the past year, a series of demonstrations were arranged in the experimental glasshouses and mushroom sheds

In tomato variety trials by the Plant Breeding Section (Mr L A Darby) special interest was shown in hybrids with the 'Baby Lea' variety, some of which are in the F_5 generation and beginning to breed reasonably true This variety has a compact habit of growth (short internodes), and an attempt is being made to incorporate this habit into known good combining varieties with the aim of producing an F_1 hybrid of good early and total yield, bearing high-quality fruit, and which will not suffer from the excessive vigour of hybrids at present grown commercially A cucumber-breeding trial, which was also demonstrated, tests the value of F_1 hybrids for commercial use with special reference to early and total yields, and to fruit quality

The Plant Physiology Department (Dr E R Leonard) showed the concluding stages of a time-of-planting experiment carried out as part of its growth analysis studies on the tomato Previous work has suggested the influence of day-length on the growth of all the major organs of the plant, including the roots, and in order to investigate this more fully sowings at one of the dates included in the main time-of-planting experiment have also been carried out at three other centres in the British Isles, ranging from Guernsey in the Channel Islands to Auchincruive in Scotland, and in Malta and Finland A prototype temperature-controlled glass cabinet, erected in a glasshouse, for studying the growth of tomato plants under controlled day-length throughout a cropping season was also on display Another exhibit was equipment for the production of artificial temperature gradients across a tomato fruit in connexion with the Department's investigation of fruit ripening disorders, including those loosely referred to as 'blotchy ripening'

The Chemistry Department's programme, under Dr G W Winsor, includes a comprehensive study of the nutrition of the tomato, and a wide range of glasshouse experiments was on view These comprise a basic factorial trial, testing nitrogen, phosphorus, potassium, calcium and magnesium, two experiments on liquid feeding, and an investigation of the effect of magnesium deficiency on yield and its control by applying magnesium sulphate to the soil or to the foliage Determinations of nutrient uptake are a special feature of these experiments Laboratory studies of tomato fruit composition were also demonstrated, these have particular reference to fruit-ripening disorders and may shed light on factors determining flavour Changes in the enzyme activity associated with ripening are also being investigated. The Department also works on other glasshouse crops, and of topical interest were the studies being made of the effects of manganese toxicity on tomatoes, lettuce and carnations A factorial nutritional trial on carnations, testing three levels of nitrogen and potassium in the presence or absence of added phosphorus, magnesium or calcium, was also on view With the cultivated mushroom certain cultural problems are studied, particular attention being paid to various factors of the casing layer in relation to fruiting, evidence has accumulated that total moisture stress has an important influence on fruiting An investigation of the effect of factors of the atmospheric environment on mushroom growth is also about to be taken up, and a prototype controlled-environment chamber for this was on view

The Plant Pathology Division (under Dr L Broadbent) demonstrated the work of its three Departments, Entomology (Dr N W Hussey), Mycology (Mr P H Williams) and Virology (Mr M Hollings) At present the Entomology Department is devoting a great deal of attention to cecids affecting the cultivated mushroom, observations on their life-history were illustrated, and results were presented on the very rapid rate of increase of the larvæ in compost The results of experiments on the control of cecids by the application of γ-BHC to compost or casing were also displayed The Mycology Department showed aspects of its work on the *Didymella* stem rot of the tomato, on cucumber mildew, on carnation wilts and on mushroom fruiting disorders In connexion with the investigation of carnation wilt diseases, a glasshouse experiment on the survival of the pathogens in soil and plant roots was in progress, this involves the growing of carnations, chrysanthemums and tomatoes in rotation in concrete-lined beds to see whether the wilt organisms can be carried over on hosts other than the carnation, even though producing no visible symptoms on those hosts Mushroom fruiting disorders, associated with greatly reduced cropping, have caused much concern to the industry during the past few years, but their investigation has proved very perplexing because of the variety of symptoms produced At the Institute the possible transmissibility of the disorders has been particularly studied, and in recent experiments, which were demonstrated, evidence of artificial transmission and natural spread following the inoculation of beds has been obtained Of special interest in the Virology Department's programme, which is about to be greatly expanded, was the success achieved in rooting meristem cultures of carnations and transferring them to conventional growing media , this work has been undertaken as a prelude to the investigation of heat therapy for carnation virus diseases

The Crop Protection Department (Mr W H Read) had a striking demonstration of the effect of captan in protecting tomato plants from *Didymella* stem rot A glasshouse trial showing the value of the chemical soil sterilizing agents, metham and chloropicrin, in comparison with steaming, was also on view

Among the current activities of the Statistics Section (Mr D Cooke) attention was directed to a survey that is to be carried out, in collaboration with Rothamsted Experimental Station and the Ministry of Agriculture, on the tomato varieties in commercial cultivation in relation to earliness and district This should provide information of particular interest in connexion with the breeding programme and experimental work generally F W Toovey

STUDIES IN RECREATION

UNDER the title "After Work Leisure and Learning in Two Towns", the National Institute of Adult Education has published, for the Manchester and District Advisory Council for Further Education, studies in Bolton and Rochdale by Mr R Ruddock and Dr A Wilson (pp 63 London National Institute of Adult Education, 1959 3*s* 6*d*) Prof R D Waller contributes an introduction explaining the purpose and basis of the two surveys, which give special attention to the twenty to thirty age group, and suggesting a few generalizations Dr Wilson's survey of Rochdale started a few months later than Mr Ruddock's survey of Bolton, and he stresses the quality and quantity of educational and cultural activity in this town of some 86,770 inhabitants While this is probably not less than that of any other industrial town of comparable size in Great Britain probably as many as 40 per cent of young adults have no connexion with any organization outside their job and home The Rochdale Literary and Scientific Society, founded in 1878, has always had the backing of influential scientists, doctors, teachers and others and often exercised considerable influence in educational and cultural matters , its membership has fluctuated between 233 and 350 during the first half of this century, but has since reached 650 Nevertheless, apart from societies promoting religious, musical, dramatic or highly specialized leisure pursuits, the voluntary societies have little success in attracting people in the 18–35 age group, and during the past five years the membership of voluntary societies has fallen by 12–13 per cent

The survey suggests that some of the young adults would welcome the opportunity to live a fuller social life and that others might adopt a similar attitude if parents, school-teachers and employers broadened their horizons and developed their latent interests in society and the problems which face its responsible citizens Dr Wilson suggests that the links between technical students and liberal or non-vocational studies could be developed, for example, by residential courses organized by the Extra-Mural Department of the University of Manchester Nor is full use yet made of the facilities for further education under the part-time day release scheme with a school population of 12,287 in sixty schools, day release from 2,289 technical college students is only 943, 76 from 243 School of Art students, and 19 from 1,883 Further Education Centre students

For Bolton, with approximately double the population (163,800), the statistical picture is similar The population per acre, rates per head and birthrate are very similar there are 25,374 students in 102 schools and the total expenditure on education is roughly double (£2,278,812 compared with £1,115,567) Of the 6,700 technical college students, 2,800 are day release, but there is no day release among 748 School of Art students and 2,700 Further Education Centre students Like Rochdale, Bolton is becoming less dependent on the textile industry, and employment in the textile industries has dropped to less than 25 per cent of the working population, compared with 47 per cent in Rochdale Mr Ruddock estimates that the voluntary societies contribute only perhaps one-twentieth to the cultural activity of Bolton and that the whole cultural life of Bolton is sustained by some 6,000 of its citizens Among the suggestions he makes, all concerned with the upper 30 per cent of the population, in the educational sense, is extended publicity to ensure that more young adults know of the Workers' Educational Association and other serious organizations in the cultural field Many premises require improving and equipment The Central Library is admirably situated for sponsoring experimental provision, and although there is much good teaching of the plastic arts in Bolton, local amateurs could benefit by experience of a more exciting and vital practice which might be offered from outside Besides the provision of special courses for those conducting classes and meetings, Mr Ruddock suggests that the many graduate teachers, lawyers, doctors, ministers, scientists and administrators in Bolton might be encouraged to associate more freely and that executive members of local businesses would gain much from organized group contacts with specialists in science, administration, education and social science, many of whom could be reached through the University Extra-Mural Department or Bolton Technical College

Prof Waller points out that neither survey says much about the large undifferentiated mass—what its members' spare-time activities are, what could be done to interest them and involve them in socially healthy and worth-while pursuits Both surveys support explicitly and implicitly Dr I Trenaman's conclusion, that all cultural and educational activities touch only about half of the population, and that half includes all those who have received higher education. It is the late school leavers who are the most likely to carry on cultural interests into mature life, and there seems good reason to believe that longer schooling, the sensible organization of continuation work and youth activities and the liberal treatment of vocational training would all considerably affect cultural and intellectual interests in later life. Prof. Waller also notes Dr. Wilson's observation that those of the 20–30 age group who are most deeply addicted to television seem to have taken no course since leaving school, have no connexion with church or voluntary society and no interest in any other local society and organization. Possibly only television could induce any desire to participate in communal activities among this group. While the position of established societies and organizations varies—the thriving state of the Bolton branch of the Workers' Educational Association contrasts with a decline of 12–13 per cent of the membership of the Rochdale branch during the past five years—all seem likely to gain from an improved educational system and a better developed service of youth. All would be helped by better and co-operative publicity, perhaps with the assistance of local authorities, and all would be greatly strengthened by public provision of central premises, available to them all without crippling rental charges.

MARITAL FERTILITY IN ENGLAND AND WALES

THE census of 1951 was the first general census since 1911 to include questions relating to the fertility of married women of England and Wales. The answers to these questions have been analysed in the fertility report which has recently been published (Census 1951. England and Wales. Fertility Report. Pp. cxi+251. London: H.M. Stationery Office, 1959. £4 10*s*. net).

The analysis of fertility movements has become of increasing interest to demographers and other social scientists for a number of reasons. In the first place, fluctuations in marital fertility and long-term changes in the fertility-rate have most important effects on the size and structure of the population, particularly in low-mortality areas like Great Britain. Secondly, differences in the fertility of various sub-groups of the population are of considerable sociological interest by themselves, and changes in differential fertility may throw important light on other aspects of social change. It is thus likely that questions on marital fertility will figure in future British censuses as a matter of routine.

The growth of interest in fertility has also led to considerable developments in the method of analysis, in particular, the use of cohort analysis in which the fertility experience of a group of women who were either born or married in the same calendar year is traced throughout their reproductive lives. This method of analysis was used in the statistical reports of the Royal Commission on population, and is now also applied in the Fertility Report in discussing the problem of population replacement.

The fertility questions asked in the 1951 census were limited to married women under the age of fifty at the time of the census. These were asked to state the date of their marriage (and their first marriage, if married more than once), the number of live-born children, and whether they had given birth to a live-born child in the twelve months preceding the census. In addition, the census schedule contained the woman's age, and, if her husband was enumerated on the same schedule, particulars relating to his occupation. In order to simplify the analysis, a sample of 20 per cent of the 7·4 million married women was selected for analysis; an 80 per cent sample of women aged 45–49 was taken to obtain more detailed data on completed fertility. A complete analysis was made of all women who had been married more than once, but such women constituted only 4·1 per cent of all married women.

The fertility report aims to answer three questions. First, what is the current level of marital fertility in England and Wales? Secondly, what differences in fertility between various groups may be detected from the data? Lastly, what are the implications of present trends on population replacement?

It will be convenient to deal with the last topic first. It is interesting to note official recognition of the fact that the question as put is incapable of being given a definite answer. On p. xci of the report a number of different hypothetical replacement-rates, calculated on different assumptions, are put forward, varying between 0·965 and 1·084. The official comment is that "current habits imply *in the long run* approximately full replacement of one generation by the next and possibly very little more" (p. xcii). This is a far cry from the position in the 1930's when warnings about incipient rapid population decline were common. To be fair, however, it should be pointed out that women born in the early years of the century did not have sufficient children to replace themselves (women born between 1903–8 had a generation replacement-rate of only 0·672, those born between 1913–18 0·795). It is clear, however, that in the immediate future, violent changes in total numbers are unlikely.

There are slight indications that the recovery in average family size after the end of the Second World War was slowing down in the middle 'fifties, but it will be necessary to wait for the 1961 census data before we can be certain of this.

It is not the function of an official census report to speculate upon the causes of the reversal in fertility trends, but the chapter on differential fertility gives information about differentials between occupational groups (both the traditional five-fold classification and the twelve socio-economic groups), between different geographical areas, and also an analysis of fertility differences by differences in the ages of husband and wife. The indices studied are mean family size, proportion infertile and current fertility-rate. These figures confirm the impression that clerical workers, shopkeepers and the lower professional, administrative and managerial groups are now the least fertile section of the population, their fertility being about 20 per cent below that of the population as a whole. On the other hand, semi-skilled and unskilled manual workers continue to show an excess of about the same amount.

The report, of course, contains much additional information, some of it incidental to the principal topic For the calculation of replacement-rates, a female nuptiality table showing the proportion of the female population at different ages by marital status had to be computed, assuming current rates of death, marriage and dissolution of marriage, and interesting facts emerge about the marriage habits of different groups of the population

One hopes that the fertility questions will be repeated in 1961, and that the questions will be asked of all married women this time It is only through periodic inquiries such as this that the fertility of the population as a whole can be adequately studied, and the importance of the subject warrants inquiries of this kind to be made at intervals more frequent than once in forty years

E GREBENIK

JOHN INNES HORTICULTURAL INSTITUTION

ANNUAL REPORT, 1958

THE accommodation and facilities at the John Innes Horticultural Institution, the annual report of which was recently published (Forty-ninth Annual Report, 1958 Pp 44 Bayfordbury, Hertford John Innes Horticultural Institution, 1959 3*s*), continue to expand In the Department of Plant Breeding, much work has been carried out in an effort to improve the apple, with special attention to breeding for apple scab and apple mildew Secondary emphasis has been placed on hybridization to fill varietal gaps Pear–apple hybrids have been found to be only possible using the pear as female parent, and there appears to be no fundamental genetic barrier to crossing the two genera, however, hormone treatment is necessary for success Very few of the hybrids have survived the seedling stage, due to rapid breakdown of root tissue This weakness is only partly overcome by grafting and only about 2 per cent of those produced up to 1956 have survived It has been claimed that parental performance can be improved by selection combined with inbreeding and that undesirable characters, such as disease susceptibility, can be removed without impairing the general breeding behaviour of the original genotypes Whether or not worth-while results can be obtained in this manner is controversial, but a programme of inbreeding strawberries has been designed to answer some of these questions The results so far suggest that selfing causes a considerable loss of vigour In practice, changes affecting only one character are seldom brought about by selection after hybridization Such changes are more likely to be achieved if genetic variability can be produced without crossing Experiments on increasing genetic variability of inbred lines of tomato by irradiation using phosphorus-32 indicate that it may be possible to increase quantitative variation in tomato by this means

Self-compatibility in the family Solanaceae and in the genus *Linaria* is being investigated in the Department of Genetics as well as the genetics of *Coprinus lagopus* The Department of Potato Genetics has continued work on various aspects of species relationships Until recently, breeding for resistance to late blight has been based on genes for resistance derived from *S demissum* At first, varieties possessing a single gene for resistance were satisfactory, but eventually succumbed to new races of *Phytophthora infestans* Resistance based on field resistance presumably controlled by a number of genes is thought to be more promising Selection of field-resistant varieties is slow and there is probably scope for varieties incorporating two or three different genes for resistance The genetic variability of the fungus is also being studied as well as resistance of potato varieties to virus *X* and virus *Y* The Department of Plant-Cell Biology has continued studies on leaf growth Observations have continued on the relative contributions of cell division and cell expansion to the second pair of leaves and the tenth leaf of *Helianthus annuus* The tenth leaf reached an area about three times greater than a leaf at the second node, on the other hand, the average volume of the cells of the tenth leaf was only about one-half that of the second leaf The greater size of the tenth leaf is therefore due to longer duration of division rather than a greater final cell size Division continued until the leaf was more than three-quarters fully grown The results refute the older idea that during early development of the leaf, growth is due mainly to formation of new cells and that after division has ceased subsequent growth is due to cell enlargement It is concluded that division and expansion do not determine leaf growth in two distinct developmental phases Experiments have been initiated to investigate the metabolic activities of the shoot apex in both its vegetative and reproductive states Observations are recorded on the terminal meristem of winter rye at a stage when the reproductive state of the apex is being initiated

In the Department of Physiology and Plant Culture much attention has been given to design of growth rooms which will give the highest practical uniformity of light intensity, air temperature, air velocity and relative humidity in the space available for plants Attention has also been directed to maximum flexibility From the experience gained it has been possible to formulate the essential features necessary in such growth rooms These facilities have been used to study the early growth and development of tomatoes In all the conditions tested, plants grown in compost were found to have a higher growth-rate than can be obtained in vermiculite watered with nutrient solution The factors involved are being studied The light/temperature regimes in glasshouses are very important and it is hoped that a detailed study will prove of value in balancing the temperature of the glasshouse (which can be controlled especially at night) with the amount of light received, which cannot be controlled If such a balance could be achieved, a great economy in glasshouse-tomato production would be attained.

A REVISED CLASSIFICATION OF THE LUDLOVIAN SUCCESSION AT LUDLOW

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RECENT detailed studies of the shelf-facies of the Ludlovian at May Hill[1], Usk[2], Woolhope[3,4] and Malvern[5] have revealed a consistent pattern of faunal divisions For some years workers in the Ludlow Research Group have been convinced that the same general pattern obtains in the type area at Ludlow Unpublished work on areas to the west of Ludlow, at Leintwardine (J H McD Whitaker) and Elton (B J Williams), has strengthened this conviction Unfortunately, the published accounts of the type area[6-8] fail to recognize the two most distinctive faunal divisions (Lower Bringewood Beds and Upper Leintwardine Beds of the proposed classification) and leave the other divisions inadequately defined, often in terms of unreliable 'zone fossils', such as *Camarotoechia nucula* and *Dayia navicula* A revision of the geology of the Silurian in the Ludlow district was, therefore, undertaken by us The area investigated extends from Downton Gorge in the west to Ludlow itself and then southwards as far as a line joining Aston and Richard's Castle , it lies between the Leintwardine area to the west and the Elton area to the south-west This work has been completed and a detailed account is being prepared for publication It will include details of localities, faunal lists, and a geological map Standard sections for the classification will be chosen, after discussion with Mr B J Williams and Mr J H McD Whitaker, from the whole area of the Ludlow anticline The detailed description of these sections, excavated if necessary, will include maps, sketches and photographs It has been considered necessary to present this preliminary synopsis of the revised classification in order to facilitate stratigraphical correlation in impending publications on other Welsh Borderland areas of Ludlovian rocks Moreover, several overseas geologists have made extensive collections based on the new scheme and need to refer to it in their publications

The revised classification and its relationship to the existing scheme are shown in Table 1

Table 1

PROPOSED CLASSIFICATION	PREVIOUS CLASSIFICATION
Upper Whitcliffe Beds	Upper Whitcliffe or *Chonetes* Flags
Lower Whitcliffe Beds	Lower Whitcliffe or *Rhynchonella* Flags
Upper Leintwardine Beds	Mocktree or *Dayia* Shales
Lower Leintwardine Beds	
Upper Bringewood Beds	Aymestry or *Conchidium* Limestone
Lower Bringewood Beds	
Upper Elton Beds	Lower Ludlow Shales
Middle Elton Beds	
Lower Elton Beds	

The introduction of new names has not been undertaken lightly and raises a number of problems These nine divisions in the Ludlovian succession are defined essentially on their characteristic faunal assemblages and are therefore biostratigraphical units[9] At Ludlow, because the faunas are to some extent facies faunas, these biostratigraphical units tend to coincide with lithostratigraphical units (divisions defined on the basis of lithological change) Consequently, they are easily mappable divisions and it may be justifiable to consider them as formations, although many stratigraphers insist that formations should be distinguished on lithological criteria alone For the kind of unit with which we are here concerned, the American Commission on Stratigraphic Nomenclature recommends the use of the term 'assemblage zone' It further recommends that such assemblage zones be named after one of the fossils of the assemblage

There are, however, serious objections to this latter practice Taxonomic revision of a fossil name which has been used in this way causes confusion Moreover, the selection of one fossil name from the assemblage is liable to throw undue emphasis on the one chosen, even when it is made clear that it serves merely as a label for a whole fauna Misunderstanding arises especially where, as is often the case, the chosen fossil actually occurs also outside the stratigraphical unit defined In fact, in the succession of faunal assemblages outlined here it would be difficult to find fossils which do not range beyond the limits of one such unit In the absence, at present, of a more satisfactory method of naming such divisions we prefer to use the non-committal term 'Beds' and to distinguish these by appropriate local place names

The *Elton* Beds are named after the village of Elton (*SO* 457 708), in the vicinity of which is the Elton Lane section described by Wood[6] in establishing her Lower Ludlow graptolite zones *Bringewood* Chase is the general name for the highest wooded ground (*SO* 458 733) between Ludlow and Downton Gorge, north of the Ludlow–Wigmore road The name *Leintwardine* (after the village at *SO* 404 740) is preferred to Mocktree[7] because of the possibility of these names being used for stages ending in -ian Finally, *Whitcliffe* (*SO* 508 742) refers to the right bank of the River Teme at Ludlow, the name of which was used by Elles and Slater[7] Its retention seems unlikely to cause confusion , but it is pointed out that these authors included the Ludlow Bone Bed within their 'Whitcliffe Flags', while we, following White[10], regard this distinctive horizon as forming the base of the Downtonian

In Wood's[6] classification of the Lower Ludlow rocks on the basis of their graptolite faunas, the *Monograptus tumsescens* zone is succeeded by the zone of *M leintwardinensis*, which is said to include the Aymestry Limestone, "above which no graptolites are known" Elles and Slater[7], and later Alexander[8], extended the recorded range of *M leintwardinensis* into the Mocktree Shales We have recorded *M tumescens* from the Lower Bringewood Beds of our classification and have found *M leintwardinensis* in the Leintwardine Beds only We know of no confirmable record of *M. leintwardinensis* from below the Leintwardine Beds

The following notes are intended as a brief indication of the essential characteristics of the subdivisions proposed Fossils are listed in each case which are common, fairly common, or characteristically present A few localities are given at which the various beds may be examined

(1) LOWER ELTON BEDS (Approximate thickness 100–150 ft) Soft, poorly bedded, shaly and flaggy, pale olive calcareous siltstones, with layers of limestone nodules The beds often have a speckled appearance due to the presence of numerous shell fragments There is a shelly fauna of Wenlockian aspect, in which small brachiopods and trilobites predominate Graptolites are exceedingly rare, these being the 'Barren Beds' of the Lower Ludlow Shales[8]

Fossils *Atrypa reticularis* (Linnæus), *Chonetoidea grayi* (Davidson), *Dicoelosia [Bilobites] biloba* (Linnæus) (characteristically present), *Leptaena rhomboidalis* (Wilckens), *Resserella [Parmorthis] cf elegantula* (Dalman), *Skenidioides lewisi* (Davidson) (characteristically present), *Dalmanites vulgaris* (Salter), *Beyrichia maccoyana* Jones

Localities (*a*) Overlying Wenlock Limestone in old quarry (*SO* 4725 7300) on south side of Ludlow–Wigmore road, about one mile north-east of Aston Church The soft siltstones of the Lower Elton Beds contrast strongly with the nodular limestones of the top Wenlock Limestone (*b*) Stream section (*SO* 4360 7265) in wood about half a mile north-west of Burrington Church

(2) MIDDLE ELTON BEDS (Approximate thickness 150–350ft) Well-bedded, shaly and thinly flaggy, light olive-grey to yellowish-grey, more or less calcareous siltstones, with smooth, conchoidal fracture Graptolites and orthoconic nautiloids predominate These are the Lower Ludlow Shales of the *Monograptus nilssoni* and *M scanicus* zones of Wood[6]

Fossils *Chonetoidea grayi* (Davidson), *Dalmanites vulgaris* (Salter), *Beyrichia maccoyana* Jones, *Monograptus bohemicus* (Barrande), *M colonus* (Barrande) (common), *M dubius* (Suess), *M nilssoni* (Barrande) (characteristically present), *M scanicus* (Tullberg) (characteristically present), *M uncinatus* (Tullberg), *M varians* (Wood), *Slava [Cardiola] interrupta* (Broderip), orthoconic nautiloids (common)

Localities (*a*) Stream bank (*SO* 4785 7328) about 580 yards south-west of Mary Knoll House (*b*) Exposures in stream referred to under Lower Elton Beds above, for example, at *SO* 4338 7264

(3) UPPER ELTON BEDS (Approximate thickness 150–250 ft) Hard, well-bedded, flaggy, light olive-grey, calcareous siltstones with occasional thin limestone bands These are the Lower Ludlow Shales of the *Monograptus tumescens* zone of Wood[6] and this graptolite is the only common fossil

Fossils *Chonetes lepisma* (J de C Sowerby), *Lingula lata* J de C Sowerby, *Monograptus tumescens* Wood (common and characteristic), orthoconic nautiloids

Localities (*a*) Roadside exposure at Gorsty Farm (*SO* 4785 7355) (*b*) Exposures in steep wooded slope above River Teme (*SO* 431 728), about half a mile north-west of Burrington Bridge

(4) LOWER BRINGEWOOD BEDS (Approximate thickness 160–200 ft) Irregularly bedded, flaggy, pale greyish-olive to greenish grey, calcareous siltstones, with limestone nodules Large brachiopods, particularly strophomenids, are abundant These beds have not previously been distinguished but have probably been included in the Aymestry Limestone

Fossils *Atrypa reticularis* (Linnæus); *Brachyprion* sp nov, *Dalmanella orbicularis* (J de C Sowerby), *Gypidula lata* Alexander, *Leptaena rhomboidalis* (Wilckens), *Leptostrophia filosa* (J de C Sowerby), *Shaleria* sp nov, *Sphaerirhynchia [Wilsonia] wilsoni* (J Sowerby), *Strophonella euglypha* (Hisinger), *Strophonella funiculata* (McCoy), *Dalmanites vulgaris* (Salter), *Poleumita globosa* (Schlotheim); bryozoa

Localities (*a*) Old quarry on south side of Ludlow–Wigmore road (*SO* 4825 7373), about 140 yards north-east of Mary Knoll House (*b*) (*SO* 4940 7265) Sections 200 yards north-west of Sunnyhill Cottages

(5) UPPER BRINGEWOOD BEDS (Approximate thickness 40–150 ft) Hard, irregularly bedded, flaggy and nodular, greenish-grey silty limestones or grey limestones, with thin shaly partings at intervals of several feet The fauna is similar to that of the Lower Bringewood Beds, but strophomenids are less abundant, whereas *Conchidium knightii* and compound corals become common These beds constitute the familiar Aymestry Limestone as seen at Aymestrey and View Edge

Fossils *Atrypa reticularis* (Linnæus) (common), *Conchidium knightii* (J de C Sowerby) (characteristically present), *Gypidula lata* Alexander, *Leptaena rhomboidalis* (Wilckens), *Sphaerirhynchia [Wilsonia] wilsoni* (J Sowerby), *Strophonella euglypha* (Hisinger) (common), *Favosites* sp (characteristically present), *Heliolites* sp (characteristically present), solitary corals, stromatoporoids (characteristically present), crinoid columnals

Localities (*a*) Old quarry (*SO* 4851 7370) at north end of Mary Knoll (*b*) East side of River Teme just south of Bow Bridge (*SO* 4306 7313)

(6) LOWER LEINTWARDINE BEDS (Approximate thickness 100 ft) Flaggy, light olive-grey, calcareous siltstones, with bands of shelly limestone which weather to dark yellowish-brown rottenstones Brachiopods are abundant, but many species characteristic of the Bringewood Beds have disappeared (for example, *Conchidium knightii*, *Gypidula lata*, *Strophonella euglypha*), corals and stromatoporoids are also absent These beds are roughly equivalent to the *Dayia* or Mocktree Shales of Elles and Slater[7]

Fossils *Atrypa reticularis* (Linnæus) (common), *Camarotoechia [Rhynchonella] nucula* (J de C Sowerby), *Chonetes lepisma* (J de C Sowerby) (common), *Dalmanella orbicularis* (J de C Sowerby) (common), *Dayia navicula* (J de C Sowerby) (common), *Leptaena rhomboidalis* (Wilckens), *Lingula lata* J de C Sowerby, *Shaleria ornatella* (Davidson) (common in the higher beds), *Sphaerirhynchia [Wilsonia] wilsoni* (J Sowerby) (common), *Monograptus leintwardinensis* Lapworth (characteristically present)

Localities (*a*) Quarry at Sunnyhill Cottages (*SO* 4954 7253) (*b*) Old quarry (*SO* 4375 7307) at top of wooded scarp of Burrington Hays showing Lower Leintwardine Beds on Upper Bringewood Beds (*c*) Deep roadside quarry (*SO* 4910 7399), about 1,050 yards east-north-east of Mary Knoll House, showing uppermost Lower Leintwardine Beds

(7) UPPER LEINTWARDINE BEDS (Approximate thickness 5–20 ft) Irregularly bedded, flaggy, light olive-grey, calcareous siltstones, with an abundant and most distinctive faunal assemblage There are several trilobite species and an overlap of the brachiopod faunas characteristic of the lower and upper parts of the succession Thin 'biscuity' dark yellowish-brown layers, crowded with *Beyrichia lauensis* and *Chonetoidea grayi* are characteristic of exposures in the western part of the district This important division was not recognized by previous authors but appears to have been for the most part included in the *Dayia* or Mocktree Shales of Elles and Slater[7]

Fossils *Camarotoechia* [*Rhynchonella*] *nucula* (J de C Sowerby), *Chonetes striatellus* (Dalman), *Chonetoidea grayi* (Davidson) (common in the west), *Dalmanella lunata* (J de C Sowerby), *D orbicularis* (J de C Sowerby), *Leptaena rhomboidalis* (Wilckens), *Shaleria ornatella* (Davidson) (common in the east), *Calymene neointermedia* R and E Richter (characteristically present), *Encrinurus* sp, Proetid trilobite, *Beyrichia lauensis* Kiesow (characteristically present)

Localities (*a*) Small roadside exposure (*SO* 4925 7406) about three-quarters of a mile east-north-east of Mary Knoll House (*b*) Small old quarry (*SO* 4542 7370) above Forestry Commission track which leads from (*SO* 4595 7405) near Deepwood southwards, and then westwards across the wooded slopes of Bringewood Chase Other small exposures by this track are at *SO* 4550 7371 and *SO* 4588 7374

(8) LOWER WHITCLIFFE BEDS (Approximate thickness 80 ft) Irregularly bedded, massive or thickly flaggy, olive-grey to dusky-yellow, calcareous siltstones, with occasional calcareous nodules and with contorted siltstones at the top Fossils are not abundant Many of the brachiopods characteristic of the Leintwardine Beds have disappeared and mollusca have become important These beds are the Lower Whitcliffe or *Rhynchonella* Flags of Elles and Slater[7]

Fossils *Camarotoechia* [*Rhynchonella*] *nucula* (J de C Sowerby) (common), *Chonetes striatellus* (Dalman) (small form commonest), *Dayia navicula* (J de C Sowerby) (common in certain beds only), *Fuchsella* [*Orthonota*] *amygdalina* (J de C Sowerby), *Michelinoceras* [*Orthoceras*] *imbricatum* (Wahlenberg), *Serpulites longissimus* J de C Sowerby

Localities (*a*) Roadside exposure (*SO* 4940 7413) just over three-quarters of mile north-east of Mary Knoll House (*b*) Quarry (*SO* 4973 7247) about 300 yards east-south-east of Sunnyhill Cottages, with *Dayia navicula* fairly common (*c*) Old quarry at western side of Hay Mill (*SO* 4348 7351) and exposures in south bank of River Teme east of the mill for about one-third of a mile

(9) UPPER WHITCLIFFE BEDS (Approximate thickness 100 ft) Well-bedded, flaggy, light olive-grey to dusky yellow, calcareous siltstones, with shelly limestone bands Fauna similar to that of the Lower Whitcliffe Beds but brachiopods have become abundant These are the Upper Whitcliffe or *Chonetes* Flags of Elles and Slater[7]

Fossils *Camarotoechia* [*Rhynchonella*] *nucula* (J de C Sowerby) (common), *Chonetes striatellus* (Dalman) (common), *Dalmanella lunata* (J de C Sowerby) (common), *Beyrichia kloedeni* McCoy var *torosa* Jones, *Fuchsella* [*Orthonota*] *amygdalina* (J de C Sowerby), *Pteronitella cf retroflexa* (Wahlenberg), *Michelinoceras* [*Orthoceras*] *bullatum* (J de C Sowerby), *Serpulites longissimus* J de C Sowerby

Localities (*a*) Whitcliffe (*SO* 5095 7415) on right bank of River Teme at Ludlow (*b*) Exposures above eastern bank of River Teme south-westwards from Downton Castle Bridge, for example, at *SO* 4416 7411

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EFFECT OF SOME NEUROMUSCULAR BLOCKING AGENTS ON MITOCHONDRIAL ENZYME SYSTEMS

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THE pyrrolizidine alkaloids lasiocarpine and heliotrine have been shown[1] to block impulse transmission across neuromuscular junctions These alkaloids also inhibit oxidations by pyridine nucleotide-dependent dehydrogenases of liver mitochondria *in vitro*[2] The same structural locus on the alkaloid molecule appears to be responsible for inhibition of impulse transmission and of mitochondrial oxidations As the N-oxides of lasiocarpine or heliotrine affect neither transmission at neuromuscular junctions nor the activity of mitochondrial enzymes, the inhibitory locus is likely to be the nitrogen atom of the cyclic nucleus The neuromuscular blocking action of pyrrolizidine alkaloids resembles the activity of *d*-tubocurarine in certain respects *d*-Tubocurarine contains two quaternary nitrogen atoms as the inhibitory centres and it was of interest to determine whether this alkaloid also inhibited mitochondrial enzyme systems For similar reasons the effect on mitochondria of *dl-tris*-1 10-phenanthroline ruthenium (II) perchlorate [$\mathrm{Ru(phen)}_3^{++}$], a complex ion[3], was investigated

$\mathrm{Ru(phen)}_3^{++}$ has been shown to exert a curare-like effect at the neuromuscular junction[4] This cation is a co-ordinately saturated metal chelate of high chemical stability and does not contain specific active groups or centres Any biological activity which it may have is thus of a physical nature and is referable to the charge it carries[4,5]

In common with lasiocarpine and heliotrine, both *d*-tubocurarine and $\mathrm{Ru(phen)}_3^{++}$ were found to inhibit *in vitro* the activity of mitochondrial enzyme

Table 1 INHIBITION OF L-MALATE OXIDATION AND EFFECT OF CO-FACTORS

Time (min)	Interval oxygen uptake (μl)					
	Control	*d*-Tubocurarine 0 001 *M*	Ru(phen)$_3^{++}$ 0 0005 *M*	Control +co-factors	*d*-Tubocurarine 0 001 *M* +co-factors	Ru(phen)$_3^{++}$ 0 0005 *M* +co-factors
10	45	42	45	51	54	57
	Side-arm contents tipped and equilibrated for 10 min					
10	39	27	21	54	48	48
20	24	9	9	42	36	39
30	21	6	7	42	27	30
40	18	0	0	42	30	36

System Adenosine monophosphate 0 001 *M* , magnesium sulphate 0 0067 *M* , potassium chloride 0 025 *M* , cytochrome *c* 0 00001 *M* , NaK phosphate buffer, *p*H 7 4, 0 0133 *M* , L-malate 0 01 *M* , water to 3 ml final volume, mitochondria equivalent to 100 mgm fresh liver added in 0 25 *M* sucrose , temperature 38° C , gas phase air , equilibration period 10 min , 0 1 ml 20 per cent potassium hydroxide in centre well to absorb carbon dioxide Inhibitors and water (control flasks) added from side-arms after 10 min incubation Co-factors diphosphopyridine nucleotide 0 0005 *M* and reduced glutathione 0 00067 *M* added in nicotinamide 0 04 *M*

systems which require pyridine nucleotides for electron transfer The oxidations of citrate, L-glutamate, α-oxoglutarate, L-malate and octanoate, all of which are dependent on pyridine nucleotide, are inhibited by *d*-tubocurarine and Ru(phen)$_3^{++}$ as well as by lasiocarpine and heliotrine On the other hand, the activity of the succinoxidase system which does not require a pyridine nucleotide is increased in mitochondria suspended in 0 25 *M* sucrose by each of the agents

Experimental results are recorded in Table 1 to show the concentrations necessary to produce inhibition of L-malate oxidation, the rate of development and degree of inhibition and the significant reversal of inhibition obtained by supplementing the reaction mixture with diphosphopyridine nucleotide, nicotinamide and reduced glutathione

Clearly these agents inhibit mitochondrial enzyme systems by causing the loss or inactivation of pyridine nucleotides and, possibly, other respiratory co-factors Such an effect could result from increased permeability of mitochondrial membranes allowing diffusion of soluble co-factors from the particles

Mitochondrial permeability may be assessed spectrophotometrically by measuring at 340 mμ the rate of production of reduced diphosphopyridine nucleotide from diphosphopyridine nucleotide added externally to intact mitochondria oxidizing a diphosphopyridine nucleotide-dependent substrate[6,7] The rate of reduction of diphosphopyridine nucleotide is directly proportional to the permeability of the mitochondrial membrane to the passage of diphosphopyridine nucleotide into the particle No effect of heliotrine, lasiocarpine, *d*-tubocurarine or Ru(phen)$_3^{++}$ on mitochondrial permeability could be demonstrated using this system However, it was realized that the experimental conditions were very different from those obtaining in the system used for respiratory experiments Mitochondria re-isolated from a respiratory experiment in which they were subjected to 0 001 *M* *d*-tubocurarine or 0 0067 *M* lasiocarpine were found to be more permeable to the entry of diphosphopyridine nucleotide than incubated control mitochondria More simply, it was possible to demonstrate an effect of the alkaloids on mitochondrial membrane permeability in the following manner Mitochondria equivalent to 800 mgm of fresh rat liver were suspended in 5 ml of 0 25 *M* sucrose containing 0 01 *M* L-malate and 0 001 *M* *d*-tubocurarine or 0 01 *M* lasiocarpine and placed in an incubator at 37° C for 30 min , during which time the temperature of the reaction mixture rose to 32° C The mitochondria were re-isolated by centrifugation after the addition of 35 ml ice-cold 0 25 *M* sucrose and resuspended in 0 25 *M* sucrose or water as required Permeability of the mitochondria was then assessed by the spectrophotometric method[6] Fig 1 shows that incubation in the presence of lasiocarpine or *d*-tubocurarine increases the permeability of mitochondrial membranes to the passage of diphosphopyridine nucleotide The initial differences in optical density at 340 mμ of the curves in Fig 1 are due to reduction of diphosphopyridine nucleotide at different rates during the short time between adding the enzyme and taking the first reading Suspension of mitochondria in water instead of 0 25 *M* sucrose abolishes selective semipermeability of the membranes and also the effect of both the alkaloids

Finally, it was possible to show that mitochondrial permeability increases rapidly under the oxidizing conditions of respiratory experiments and is present at the time oxidative inhibitions by the pyrrolizidine alkaloids, *d*-tubocurarine or Ru(phen)$_3^{++}$ are expressed The observation was made that each of these agents stimulated the oxidation of succinate

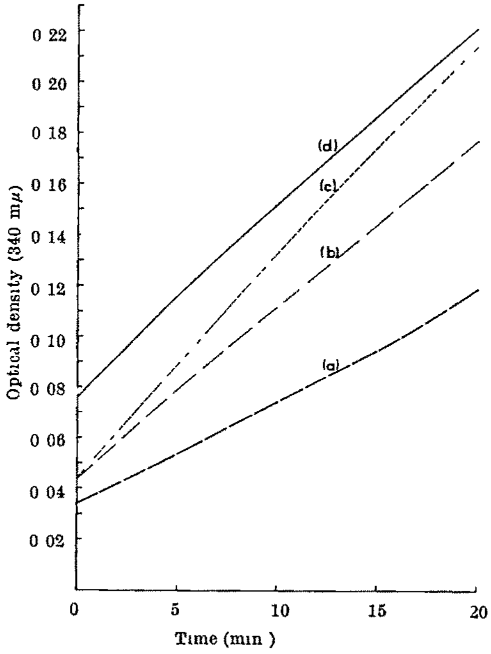

Fig 1 Reduction of diphosphopyridine nucleotide by liver mitochondria in 0 25 *M* sucrose Mitochondria preincubated with (*a*) L-malate 0 01 *M* , (*b*) L-malate 0 01 *M* + *d*-tubocurarine 0 001 *M* , (*c*) L-malate 0 01 *M* + lasiocarpine 0 01 *M* , (*d*) no addition System NaK phosphate buffer, *p*H 7 8, 0 033 *M* , potassium chloride 0 025 *M* , magnesium sulphate 0 0067 *M* , L-malate 0 05 *M* , semicarbazide hydrochloride (neutralized) 0 17 *M* , diphosphopyridine nucleotide 0 0015 *M* , potassium cyanide 0 0002 *M* , enzyme, 50 μl 1 per cent mitochondria (rat liver) in 0 25 *M* sucrose , final volume 3 ml , gas phase air , temperature 22° C

Table 2 EFFECT OF *d*-TUBOCURARINE, LASIOCARPINE AND DIPHOSPHOPYRIDINE NUCLEOTIDE (DPN) ON SUCCINATE OXIDATION

Time (min)	Interval oxygen uptake (μl)					
	Control	*d*-Tubocurarine 0 001 *M*	Lasiocarpine 0 0067 *M*	DPN	*d*-Tubocurarine 0 001 *M* + DPN	Lasiocarpine 0 0067 *M* + DPN
10	66	64	75	62	21	36
20	59	65	76	41	18	32
30	40	50	51	33	14	26

System As Table 1 with succinate 0 01 *M* as substrate and all flask contents in main chamber

by mitochondria in 0 25 *M* sucrose This was thought possibly to be due to increased permeability of mitochondrial membranes allowing the loss of mitochondrial diphosphopyridine nucleotide and thus preventing the production of oxaloacetate which in low concentration inhibits succinic dehydrogenase specifically[8] The suggestion received strong support from the lack of any effect of lasiocarpine, heliotrine or *d*-tubocurarine on succinate oxidation by mitochondria in water, which would not be producing oxaloacetate Conclusive evidence was obtained by the addition of diphosphopyridine nucleotide to mitochondria oxidizing succinate in the presence of each of the agents Diphosphopyridine nucleotide added externally to intact mitochondria enters the particles slowly unless the permeability of mitochondrial membranes is increased Succinate oxidation by mitochondria in 0 25 *M* sucrose was slightly inhibited by the addition of diphosphopyridine nucleotide alone but was rapidly and greatly inhibited by the combination of diphosphopyridine nucleotide and any one of the agents (Table 2) When mitochondria were suspended in water, diphosphopyridine nucleotide produced maximum inhibition of succinate oxidation alone and lasiocarpine, heliotrine or *d*-tubocurarine did not affect the rate of oxidation when added to systems with or without diphosphopyridine nucleotide Similarly, the addition of 0 0004 *M* Ca^{++} to mitochondria in 0 25 *M* sucrose stimulates succinate oxidation by increasing mitochondrial permeability and facilitates penetration of the particles and inhibition by added diphosphopyridine nucleotide

Table 2 shows typical experiments with *d*-tubocurarine and lasiocarpine, similar results were obtained with heliotrine and $\mathrm{Ru(phen)}_3^{++}$ It is clear that each of the agents increases the permeability of mitochondrial membranes to the entry of diphosphopyridine nucleotide

The effect of pyrrolizidine alkaloids, *d*-tubocurarine and $\mathrm{Ru(phen)}_3^{++}$ on mitochondrial diphosphopyridine nucleotide is being investigated and will be reported elsewhere

It is thus shown that these three types of chemically dissimilar compounds have actions in common on neuromuscular junctions and on liver mitochondria At each site selective semi-permeable membranes are involved We suggest that the mechanism of action of the agents may be identical at the neuromuscular junction and on mitochondrial membranes and, further, that, as the biological activity of $\mathrm{Ru(phen)}_3^{++}$ is due only to the charge carried, the activities of pyrrolizidine alkaloids and *d*-tubocurarine may also be referable to the charge carried on the nitrogen atoms

We wish to thank Dr Price and Dr Culvenor, of the Chemical Research Laboratories, for preparing the pyrrolizidine alkaloids, and Dr Dwyer, of the National University, Canberra, who prepared *dl-tris*-1 10-phenanthroline ruthenium (II) perchlorate We acknowledge gratefully the skilled and careful technical assistance of Miss Flint-Gallé and Miss Mann

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EFFECT OF DIETARY FAT AND EXTENT OF BLOOD SAMPLING ON THE LEVEL OF PLASMA CHOLESTEROL IN THE RAT

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IN the course of an investigation of the effect of certain dietary fats on the plasma cholesterol-level of the white rat, increases in the level of this substance were found which were at first attributed to the effect of dietary fat but which, on further study, were found to be due to the combination of this component and the frequency and extent of blood sampling

Male white rats were placed on formula diets similar to those used by Beveridge *et al* [1] in studies on man Fat supplied 28 4 and 58 5 per cent total calories, protein, 16 9 per cent Plasma cholesterol determinations were made by the method of Sperry and Webb[2] modified to permit duplicate determinations on 0 1 ml of rat plasma Blood samples were taken by tail section, using powdered heparin as the *in vitro* anticoagulant

In Table 1 are shown the effects of varying dietary fat and blood sampling procedure on plasma cholesterol-levels In experiment 1, groups maintained on a high and a moderate fat intake were compared with those receiving their stock diet of 'Purina' fox chow Blood samples of 2–3 per cent of total blood volume were taken from all groups on alternate days for the first 8 days, and weekly thereafter At the end of 35 days of feeding, the groups receiving corn oil showed a highly significant increase in plasma cholesterol, while those on fox chow remained unchanged. The group receiving a high fat intake

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Table 1 EFFECT OF DIETARY FAT AND EXTENT OF BLOOD SAMPLING ON PLASMA CHOLESTEROL-LEVEL IN THE RAT

Experiment No	Blood sampling procedure	Diet	Number of animals	Initial mean plasma cholesterol (mgm /100 ml)	Duration of test (days)	Final plasma cholesterol (mgm /100 ml)	Av group percentage change	*P*
1	Blood sample of 2 per cent blood volume taken on alternate days for the first 8 days and weekly thereafter	*HC* *MC* Chow	14 14 14	80 5± 6 9 75 7± 9 3 76 4± 9 5	35 35 35	96 5±12 3 86 2± 9 9 76 6± 7 8	+20 5 +13 5 +0 3	<0 01 <0 01 Non-sig
2	Blood sample of 0 5–1 0 per cent blood volume taken on first and final days only	*HC* *FF*	30 30	64 8±12 4 75 4± 9 4	14 14	64 6±12 4 70 2±12 4	−0 3 −6 9	Non-sig Non-sig
3	Blood sample of 1–1 5 per cent blood volume taken on alternate days for 6 days	*HC* *FF*	20 20	73 7±11 1 71 8±11 7	6 6	96 6±10 7 78 8±15 7	+31 1 +9 8	<0 01 Non-sig
4	Blood sample of 2 5–4 per cent blood volume taken on alternate days for 6 days	*HC* *FF*	15 15	67 2±14 3 67 7±12 8	6 6	150 0±18 0 107 7±27 2	+122 4 +59 0	<0 01 <0 01

Diets used *HC*, corn oil, 58 5 per cent cal , *MC*, corn oil, 28 4 per cent cal , *FF*, essentially fat-free , Chow, 'Purina' fox chow

demonstrated an increase of 20 5 per cent, while those on a moderate intake increased only 13 5 per cent during this period, the difference being highly significant

This elevation in plasma cholesterol of the groups fed corn oil was paralleled by other groups receiving formula diets containing butter, beef dripping, coconut oil and corn oil supplemented with cholesterol to equal the concentration present in butter (not here reported) In each case the elevation in plasma cholesterol was dependent on the concentration at which the fat was fed and not upon the nature of the fat Because of the consistency of the hypercholesterolæmia with all fats examined and the gradation of response in proportion to the level at which the fats were supplied, it appeared certain that the increase in plasma cholesterol was dependent solely upon the presence of dietary fat

However, repetition of the study in the second experiment, in which the group fed corn oil was compared with the more suitable control group consuming fat-free formula rather than fox chow, failed to reveal any change in plasma cholesterol after 14 days The animals had blood samples of 0 5–1 0 per cent of total blood volume removed only at the start and conclusion of the test The only difference in the conditions of the first two experiments that appeared to offer any rational basis of explanation for the apparently divergent results was the difference in the extent and frequency of blood sampling This was, at first regarded as unlikely, since no reports of hæmorrhage causing a lipæmia in the rat similar to that described for the rabbit and guinea pig could be found in the literature

However, in experiment 3, a group of rats fed a diet supplying 58 5 per cent of total calories in the form of corn oil was compared with a similarly matched group on a fat-free diet Both were subjected to bleeding on alternate days for a period of 6 days, during which blood samples of 1–1 5 per cent of total blood volume were taken The group on the high-fat ration showed an increase in plasma cholesterol of 31 1 per cent during this period, while those on the fat-free diet showed no significant change An increase in the amount of blood taken to 2 5–4 per cent of total blood volume, in experiment 4, produced an increase in plasma cholesterol of 122 per cent in the animals on the high fat intake Even animals on the fat-free diet showed an increase of 59 per cent

It was now apparent that the hypercholesterolæmia found in experiment 1 could not be attributed to an uncomplicated response to dietary fat, but was the product of both dietary fat and the degree of hæmorrhage to which the animals were subjected Under conditions of low bleeding stress, a high fat diet, as in experiment 2, caused no change in plasma cholesterol When bleeding was increased to 1–1 5 per cent of total blood volume on alternate days for 6 days (experiment 3), a high corn oil diet produced a significant increase in plasma cholesterol, although the animals on a fat-free diet and under the same conditions of bleeding showed no change Thus the hypercholesterolæmia is a combined effect of diet and hæmorrhage When bleeding stress was increased to 2 5–4 per cent of blood volume on alternate days for 6 days, highly significant increases in plasma cholesterol resulted in both the high-fat and fat-free groups These results, therefore, clearly indicate that the hypercholesterolæmia due to severe hæmorrhage does not depend solely on the presence of dietary fat although it is augmented by the latter

This response of the rat to bleeding stress and dietary fat has not, to our knowledge, been previously reported It is suggestive of the lipæmia of hæmorrhage obtained in the rabbit[3,4] and guinea pig[5,6] There is a difference, however , Spitzer[7], on investigating the lipæmia produced in rabbits on a high-fat diet, found it necessary to bleed to 10–15 per cent of blood volume on successive days to elicit the response, and also found that the animal recovered in about the same time necessary to induce the hyperlipæmia The rats were never bled more severely than 2 5–4 per cent of blood volume on alternate days to produce the hypercholesterolæmia on high-fat diets, and from experiment 1 there is evidence that these elevations in plasma cholesterol are maintained for periods of time as long as 5 weeks after the period of severe bleeding

Although no substantiated explanation of this phenomenon can be advanced at the present time, we wish to bring it to the attention of other workers in this field as a possible explanation of some of the conflicting reports on the effect of dietary fat on the plasma cholesterol-level of the rat

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NONHÆM IRON IN ERYTHROCYTES AS A PRECURSOR FOR HÆMOGLOBIN

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THE existence of nonhæm iron in erythrocytes from peripheral blood has long been a matter of dispute The presence of iron receptors has been suggested by Walsh *et al*[1] and Jandl *et al*[2] have shown in experiments with radioactive iron that reticulocytes take up iron *in vitro* and that this iron is bound to the stroma and incorporated into hæm Recently, Bernard *et al*[3] and Lambrechts and Thimus[4] have found nonhæm iron fairly constantly in erythrocytes from normal and pathological human blood as the difference between total iron and hæmoglobin iron The presence of nonhæm iron in the stroma of immature red cells in bone marrow has been demonstrated by electronmicroscopy[5,6]

The purpose of the present work has been to verify the existence of nonhæm iron in the stroma of normal, mature red cells and demonstrate its significance in hæmoglobin synthesis by means of *in vivo* experiments with radioactive iron

A modification of the method of successive hæmolysis used by Hillier and Hoffman[7] for preparation of hæmoglobin-free red cell 'ghosts' for electronmicroscopy was chosen The ghosts appeared greyish-white, and no hæmoglobin could be demonstrated spectrophotometrically, but there was still a faint positive benzidine reaction

Estimations of stroma iron were carried out on blood samples taken for ten successive days from a patient with recently diagnosed genuine hæmochromatosis The disease was mild, and the patient may be regarded as hæmatologically normal The iron contents of ghosts prepared from 16 ml of packed red cells ranged from 41γ to 125γ with an average of 76γ A few determinations on ghosts from normal humans and rabbits gave values within the above-mentioned limits

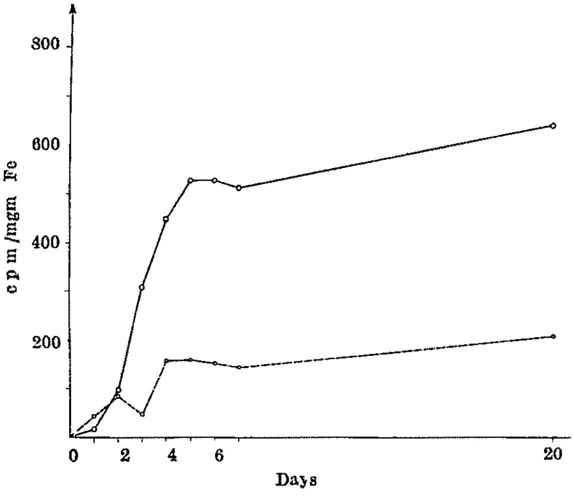

Fig 1 Incorporation of iron-59 in hæmoglobin and stroma iron in a patient with genuine hæmochromatosis ○—○, hæmoglobin iron, ○- - -○, nonhæm iron

In order to estimate the significance of this stroma iron in hæmoglobin synthesis this patient was given 8 5 μc iron-59 intravenously Blood samples were taken daily, and after determination of the amount of stroma iron, this was electroplated on copper disks and the β-radioactivity measured by a Geiger–Muller tube As will be seen from Fig 1, the specific activity of the stroma iron was higher than that of the hæmoglobin iron on the first day after administration of iron-59, but lower on the following days, quickly reaching constant values of about one-third of the specific activity of hæmoglobin iron Owing to the very low counting rate on the first day it was deemed necessary to explore this early phase further

Four female rabbits of the same age and weight were injected intravenously with about 10 μc iron-59 each The animals were killed after 1, 2, 5 and 22 hr, respectively, and a sufficient amount of blood to provide 16 ml of packed erythrocytes was obtained from each animal Stroma iron and radioactivity was determined as previously The results appear in Table 1

Table 1

Hours after injection of iron-59	Stroma iron in γ per 16 ml packed erythrocytes	Specific activity of stroma iron (c p m /mgm iron)	Specific activity of hæmoglobin iron (c p m /mgm iron)
1	84	550	370
2	98	13,540	3,780
5	75	2,020	5,750
22	80	2,060	9,190

There is a very high rate of incorporation in the stroma iron of the erythrocytes released during the first hours, but already after 5 hr the specific activity of hæmoglobin is higher than that of stroma iron These findings strongly support the view that stroma iron acts as an intermediate between transport iron of plasma and hæmoglobin

That this transfer mechanism may be blocked artificially appears from the results of Bénard *et al*[8] and Jandl *et al*[2], who show by means of iron-59 that there is practically no synthesis of hæm *in vitro* in blood containing lead ions That a similar blocking may be an important factor in certain anæmias is seen from an experiment performed on a patient with severe anæmia, characterized, after splenectomy, by a considerable amount of siderocytes in the peripheral blood. The anæmia was probably of the type described by Dacie *et al*[9] This patient was given 14 3 μc iron-59 intravenously and a week later the specific activities of stroma iron and hæmoglobin iron were estimated Despite the considerable period of time which had elapsed since the administration of iron-59 the specific activity of stroma iron was more than four times higher than that of hæmoglobin iron, the specific activities being 1,660 c p m /mgm iron and 360 c p m /mgm iron, respectively This strongly supports the view that blocking of the transport system of iron in the stroma of red blood cells may play an important part in this anæmia

The chemical nature of the stroma iron is still unknown , but experiments which are in progress in this laboratory indicate that it may at least in part, consist of ferritin

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EXTREME SENSITIVITY OF GERMINATION AND PHOTOPERIODIC REACTION IN THE GENUS *CHENOPODIUM* (TOURN.) L.

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PLANTS of *Baeria chrysostoma*[1] and *Pharbitis nil*[2] are known to respond to photoperiod at a very early stage in growth *Chenopodium rubrum* L is particularly valuable as an experimental plant since floral initiation can occur very rapidly when seed is germinated under 8-hr short days in Petri dishes[3] In addition, one photo-inductive short day may initiate floral formation (as shown in *Xanthium pennsylvanicum*[4] and *Pharbitis nil*[2]), while, in germination, there are red/infra-red and red/blue reversal effects (as shown in lettuce[5,6]) Furthermore, there is marked sensitivity to temperature in germination

Detailed comparisons of flowering have been made between selections of four species of *Chenopodium* (*a*) *C rubrum* L , (*b*) *C salinum*, Standley (syn *C glaucum* var *salinum* (Standley) Boivin) , (*c*) *C glaucum* L (syn *C glaucum* L var *glaucum* Aellen) , (*d*) *C album* L Under 8-hr short days, with alternating temperatures of 15° C for 16 hr in darkness and 25° C for 8 hr in light of 1 200 foot-candles (fluorescent combined with incandescent), that is, 15–25° C , the least number of days from seed imbibition (on moistened filter paper in Petri dishes) to visible floral formation, has been, in species (*a*) 6, (*b*) 12, (*c*) 20, (*d*) 36 The corresponding minimum true leaf numbers were in species (*a*) 2, (*b*) 2, (*c*) 2–4, (*d*) 4 Alternating temperatures of 15–25° C to 20–30° C are optimal for floral initiation in these species Floral initiation may occur under intensities as low as 150 foot-candles (fluorescent combined with incandescent), although less rapidly Fig 1*a* illustrates 100 plants of *C rubrum* 17 days after imbibition under 8-hr short days, with light of 250 foot-candles (fluorescent), alternating temperature 15–25° C , 90 per cent of the plants showed floral formation Fig 1*b* illustrates one of these plants when 21 days old , the two true leaves and four perianth members were very rudimentary , there were no stamens but the ovary produced a single viable seed after cross-pollination

Nutrients markedly influence the amount of growth and floral formation, but the response is different between species For example, under 8-hr short days with light of 1,200 foot-candles (fluorescent combined with incandescent) and alternating temperature of 23–28° C , the minimum true leaf numbers of plants grown in Petri dishes, with water as compared with Hoagland's solution, were, in species (*a*) 2 versus 2, (*b*) 2 versus 4, (*c*) 2–4 versus 4–6, (*d*) 4 versus 9–10, respectively Soil gave results similar to Hoagland's solution with an even greater leaf number occurring in *C album* The amount of floral formation was also proportionately much greater when nutrients were supplied, and stamen formation occurred even on some plants of *C rubrum* (Fig 1*c*) These results provide further evidence that the concept of minimum leaf number must be treated with circumspection[7]

Wide differences in photoperiodic sensitivity between these species are shown under 20-hr long days or continuous light, when plants are grown in soil *C album* and *C glaucum* will flower, although less rapidly than under short days In contrast, *C rubrum*, under 20-hr long days, at a temperature of approximately 24° C , has remained vegetative indefinitely (that is, at least 200 days , Fig 1*d*) With increased age *C rubrum* becomes increasingly sensitive to photoperiod and one photo-inductive cycle, that is, one 16-hr dark period following an 8-hr light period, may initiate floral formation—

Table 1 PER CENT GERMINATION OF (*a*) *C rubrum*, (*b*) *C salinum*, (*c*) *C glaucum*, (*d*) *C album*, IN DARKNESS AND UNDER 8-HR SHORT DAYS WITH CONSTANT AND ALTERNATING TEMPERATURES , 10 DAYS AFTER IMBIBITION

Temperature	Darkness (*a*)	(*b*)	(*c*)	(*d*)	8-hr short days (*a*)	(*b*)	(*c*)	(*d*)
Constant								
35° C	15	0	93	0	95	40	93	13
30° C	5	0	90	13	65	80	100	83
25° C	0	15	93	78	25	75	90	83
20° C	5	0	43	88	5	40	80	70
15° C	0	0	48	70	0	15	80	90
10° C	0	0	10	15	0	0	23	70
Alternating								
25–35° C	25	15	93	40	100	60	98	70
20–30° C	85	50	90	85	100	90	98	88
15–25° C	95	15	95	68	100	75	75	80
10–20° C	100	0	90	93	100	30	98	80

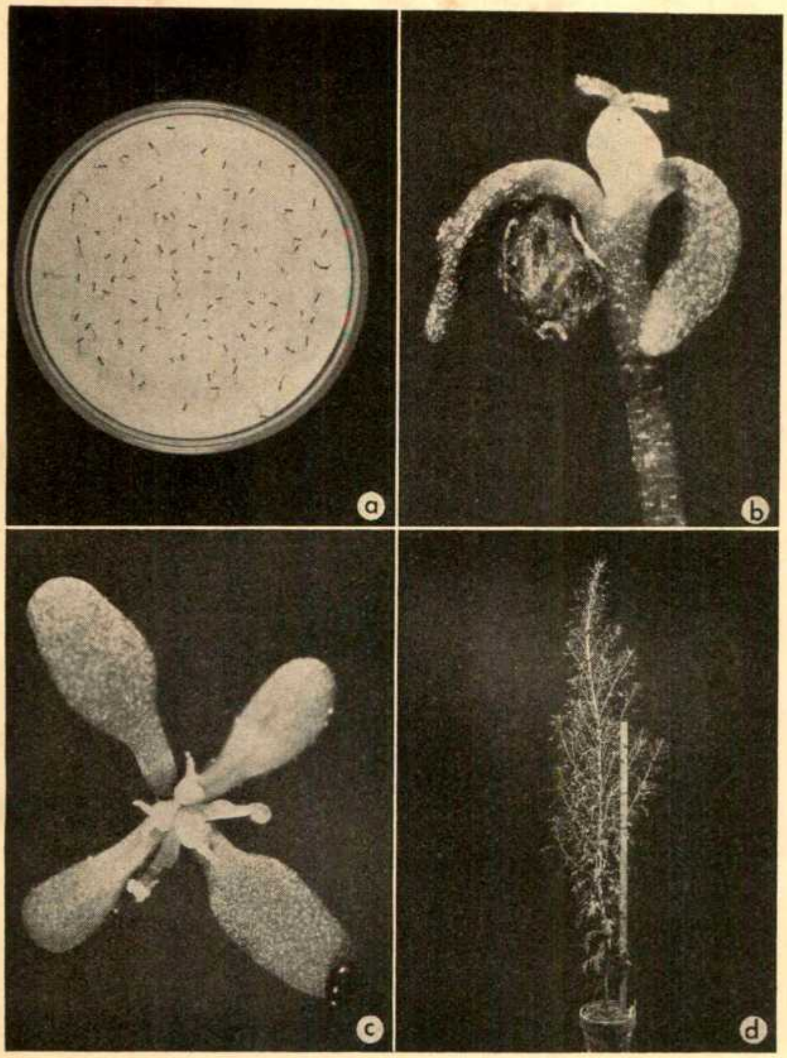

Fig. 1. *C. rubrum* L. *a*, 100 plants 17 days old, 0·8 cm. tall, 90 per cent flowering in 9 cm. × 2 cm. Petri dish ; 8-hr. short days, 250 ft.-c. (fluor.), alternating temperature 15–25° C. *b*, Flowering plant 21 days old, from *a* ; original pericarp and testa 0·6 mm. diam. still attached to cotyledon. *c*, Stamens and ovaries on plant grown with Hoagland's solution, 8-hr. short day, 1,200 ft.-c. (fluor./incand.), alternating temperature 23–28° C. ; original testa 0·6 mm. diam. *d*, Vegetative plant 200 days old, 20-hr. long days (scale : 1 m. rule)

especially if the prevailing light intensity is 2,000 foot-candles or more. With one photo-inductive cycle, depending on age and treatment, floral formation may be imperfect or delayed 6–8 weeks. Floral formation is increased in rate and amount with increase in the number of photo-inductive cycles and, under favourable conditions, it may be visible microscopically in 3–4 days and macroscopically in 6–7 days.

C. salinum appears to be intermediate between *C. glaucum* and *C. rubrum* in sensitivity to photoperiod and, while some selections have flowered within about 120 days, under 20-hr. long days, others have remained vegetative indefinitely (that is, at least 200 days). Induction of floral formation in *C. salinum* can be accomplished with one photo-inductive cycle—at an earlier stage of growth than in *C. rubrum*.

When sensitivity is evaluated by the amount of germination under different light qualities, energies, time sequences and temperatures, the species are again listed in order of sensitivity as $(a) > (b) > (c) > (d)$. Table 1 summarizes the percentage germination of non-dormant seed under constant and alternating temperatures, in darkness as compared with 8-hr. short days (250 foot-candles—fluorescent). In continuous light, germination was similar to that under 8-hr. short days. Germination of *C. rubrum* was negligible in darkness at constant temperatures $< 35°$ C. and under 8-hr. short days at constant temperatures $< 25°$ C. The lower alternating temperatures completely substituted for the light requirement in *C. rubrum* but not in *C. salinum*. Seeds of *C. rubrum* and *C. salinum* when exposed for 1 min. to white light of 50 foot-candles (fluorescent) 10 days after imbibition in darkness, germinated equally as well as under 8-hr. short days. In darkness at a constant temperature of 25° C., transfer of seeds to 10° C. for one 8-hr. period, 10 days after imbibition, initiated 100 per cent germination of *C. rubrum* and 50 per cent of *C. salinum*.

In species (a)–(d) germination can be promoted by white or red and inhibited by blue or infra-red radiation. In *C. rubrum*—the most sensitive species—at a constant temperature of 35° C., using appropriate filters and fluorescent combined with incandescent white light (1,200 foot-candles), 1 min. of white or red light supplied 8 hr. after imbibition may initiate 100 per cent germination, while 1 min of blue or infra-red radiation may completely inhibit germination ; red/infra-red and red/blue reversal effects are similar to those reported for lettuce[5,6].

These and other unpublished results that will be reported elsewhere indicate that the genus *Chenopodium* offers valuable and diverse material for experimental study. There is some evidence to support the postulation that 'weediness' of these species may be positively correlated with the amount of phenotypic 'plasticity' and with absence of sensitivity in germination and photoperiodic response. In order of distribution as weeds in Canada the species would be evaluated as *C. album* > *C. glaucum* > *C. salinum* > *C. rubrum*.

I am indebted to Dr. H. A. Senn, director of the Plant Research Institute, for the availability of extensive controlled environmental facilities, and to Dr. T. F. Cuddy, of the Plant Products Division, for the use of precisely controlled germination cabinets.

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REDOX POTENTIALS IN SOYBEAN NODULES DURING THE VEGETATIVE PERIOD

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THE attention of research workers is becoming more and more concentrated upon biochemical oxidation-reduction processes taking place during the fixation of molecular nitrogen. Rabotnova[1] established that redox potentials of leguminous root nodules are comparatively low, the *r*H-value being about 17–19. Fedorov[2], in his theory of nitrogen-fixation, also emphasizes the active role taken by various enzymatic systems under low *r*H-values. In connexion with these findings studies on the respiratory systems of rhizobia, nodules and leguminous plants require special attention. Bergersen[3] found no substantial differences between the respiratory activity of cultivated rhizobia and bacteroides from nodules during their development. Allison, Ludwig, Minor and Hoover[4] carried out respiration tests with nodules and leguminous plant roots and concluded that rhizobia in nodules are relatively inactive as regards respiration and carbohydrate consumption. The value of redox potential in nodules also represents an important condition for the activity of hydrogenase, which is regarded as having an essential part to play in the fixation of nitrogen. The role of hydrogenase in the fixation processes has been investigated by many authors, for example, Wilson, Burris and Coffee[5] and recently Hamilton, Shug and Wilson[6].

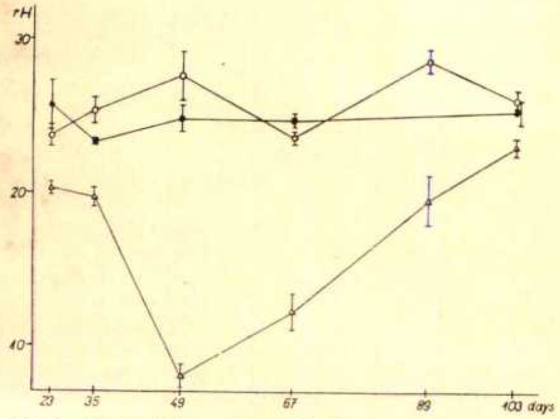

Fig. 1. *r*H values in soybeans: ○—○, stems; ●—●, roots; △—△, nodules. Standard deviation, I; abscissa, number of days after sowing

In the present work the course of the redox potential and *p*H-value in stems, roots and nodules has been followed during the whole period of vegetation and related to the increase in the number and size of nodules. Both redox potential and *p*H-value have been measured in three replicate plants with platinum and antimony micro-electrodes respectively, thrust directly into the plant organs. On each plant one nodule was chosen for the measurements. A saturated calomel half-cell was used for reference; the tests were carried out in the air. For greater simplicity in preparing graphs and easier comparison with other authors' results, the redox potential values are expressed by means of an *r*H scale (Fig. 1). As Hewitt[7] reports reasons against using the term *r*H in biological systems such as these, the ranges of measured E_h and *p*H values are also quoted in the text.

The results of the *r*H field-tests measured in plants dug up at convenient intervals are presented in Fig. 1. In the greenhouse similar results have been obtained with plants grown in sand with mineral nutrients containing 1/20 of nitrogen ratio. At suitable intervals the plants of single pots (3 plants per pot) were taken for potential measurements and estimation of nodulation and total nitrogen in plant material by the Kjeldahl method. Then the nitrogen fixation ratio in the glasshouse experiment could be calculated. Decrease of potential was observed in nodules of the same age as those in the field experiment.

Fig. 2 shows the numbers and sizes of nodules in the field-experiment during the whole period of vegetation. Until the ripening of the plants, new pink nodules originated constantly under field, as well as under greenhouse, conditions. Their *r*H values were about 10 and their ability to fix nitrogen was high, as was proved by estimation of total fixed nitrogen content in each pot in the glasshouse and by the concentration of total nitrogen in single plant organs in the field. Nitrogen fixation and nitrogen content are given in Fig. 3. Differently coloured nodules in various stages of development and with *r*H values differing by up to 13 units have been simultaneously found in the root system of one and the same plant, even on the roots of plants 103 days old. Thus, if the curve of *r*H values had to represent the actual course of the redox potential during the life of the nodule, it was always necessary to pick out for measurement only the oldest nodules in the root system of experimental plants. In the soybean root system in all our experiments nodule formation began very early, and always on the upper part of the main root. These first nodules grew very quickly and reached about ¼ in. diameter and their content became pink during

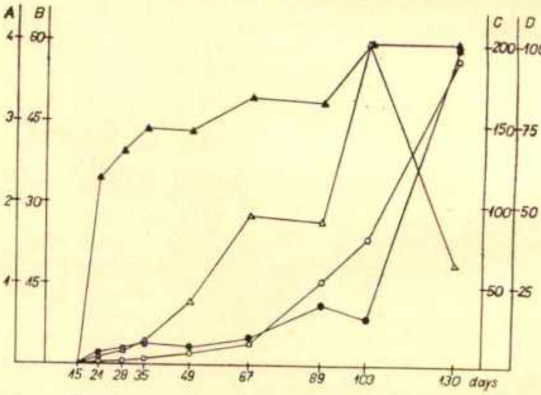

Fig. 2. Formation and growth of nodules. *A*, ○—○, volume of nodules on one plant (c.c.); *B*, ●—●, number of nodules on one plant; *C*, △—△, average volume of one nodule (µl.); *D*, ▲—▲, percentage of nodulation. Abscissa, number of days after sowing

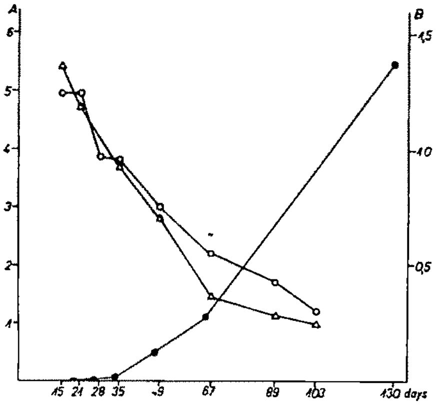

Fig 3 Nitrogen fixation and nitrogen content in plants *A*, ○—○, percentage of total nitrogen in leaves of the field plants inoculated, △—△, controls, *B*, ●—●, nitrogen (gm) fixed per pot in glasshouse Abscissa, number of days after sowing

the maximum decrease of potential, whereas other nodules scattered throughout the root system appeared and reached their largest size much later The oldest nodules for the measurements could therefore be easily picked out according to their location, size, colour and also their consistence

The tissue of the nodules differed from that of other parts of the plants not only in regard to its redox potential but also in *p*H value During the period of low redox potential (about −200 mV), the *p*H of the pink nodules varied between 7 2 and 8 7, whereas in the roots and stems it was 5 9–6 9 (potentials about + 350 mV) No differences were found between *E*h and *p*H values measured in roots and stems of inoculated and control plants

These results are evidence that the nodules on leguminous plants with quickly growing root systems originate on secondarily thickened parts of roots without root hairs and without primary cortex The appearance of new active nodules is not limited by the advancing age of the host plant, almost up to the ripening of the fruits Different values of redox potentials simultaneously measured in nodules of a single plant are in accordance with this observation The *r*H values reflect only the physiological state and age of nodules irrespective to a large degree of the age of the host When comparing the results plotted in Figs 1 and 3, we can see that a considerable fall of potential in the first nodules coincides with the beginning of nitrogen fixation observed in greenhouse and field-tests The differences in size and colour between the control and inoculated plants in the field were observed to run parallel with nitrogen content in leaves also from the seventh week after sowing

A further interesting result is that the redox potential is, to a large degree, not conditioned by the size of the nodules The size of nodules picked out for potential measurements in carrying out the field-tests was about 200 µl and remained unchanged from the beginning of fixation until the plants ripened , the observations in the greenhouse were made on nodules of about a fifth that size, but with similar results as regards absolute values and development with time

Very low values of potentials in nodules fixing atmospheric nitrogen are not opposed to the hypothesis that reduction of molecular nitrogen in nodules by hydrogen is catalysed by hydrogenases The large differences between *r*H values in various soybean organs and in nodules is evidence of specific biochemical processes taking place in the nodules during the fixation of nitrogen and show that nodules cannot be regarded as ordinary organs of the plant, as might be deduced from the experiments on rates of respiration of nodules[4]

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PHOTOREACTIVE PIGMENTS IN FLAGELLATES

Chromoprotein Pigments of Some Cryptomonad Flagellates

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THE cryptomonad flagellates are a little-known group of organisms comprising both pigmented and apochlorotic forms The pigmented forms are usually blue-green, brown, purple or red in colour and are capable of photosynthesis Until very recently, nothing was known of the pigments responsible for these colorations—the only information on record before the present work[1,2] being a personal communication from Haxo and Wolken to Provasoli[3], that *Rhodomonas lens*, a red cryptomonad, contains a phycobilin-like pigment The present communication describes water-soluble chromoprotein pigments from two blue-green cryptomonads, *Chroomonas* sp and *Hemiselmis virescens*, and a brown representative, *Cryptomonas ovata* var *palustris*

Chroomonas sp , kindly supplied by Prof E G Pringsheim, was examined in 1953 This organism could only be grown in soil–water medium and was not available in sufficient quantity for more than the measurement of the absorption spectra of whole cells and crude extracts

More extensive measurements have been made on the pigments of two other cryptomonads *Hemiselmis virescens*, obtained from Dr Michael Droop, was grown on the synthetic medium 'DC' (ref 4) Dense growth was obtained using light intensities of 1,000–1,500 lux at a temperature of 18° C Cultures were grown for twenty days in 5-litre Fernbach flasks containing 1 5 l of medium Optical densities of 2 5 were obtained by aerating the cultures

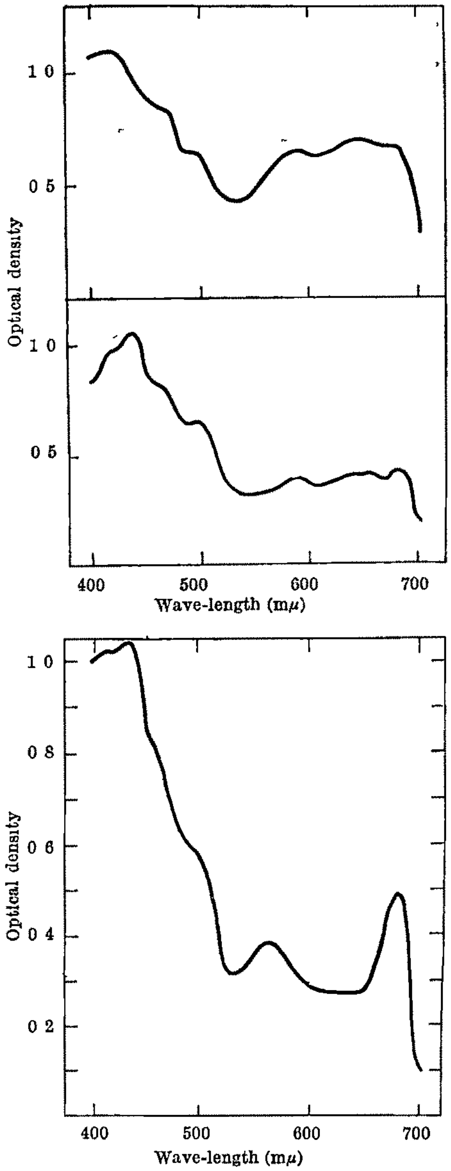

Fig 1 (*a*) Absorption spectra of cell suspensions of *Hemiselmis virescens* (top) and *Chroomonas* sp (bottom) (*b*) Absorption spectrum of cell suspension of *Cryptomonas ovata*

Cryptomonas ovata var *palustris* was obtained from Dr Richard C Starr and grown on the proteose peptone medium recommended by him[5] The light intensity during growth was approximately 800 lux, provided by a screened bank of white fluorescent lights *C ovata*, like the other cryptomonads investigated, did not grow in strong light The temperature was 23–28° C *C ovata* multiplied very slowly under these conditions , from four to six weeks was required to obtain a dense culture

For extraction of the pigments, cells were centrifuged from the culture medium and washed, and the packed cell mass frozen and thawed, or allowed to stand a few hours in the refrigerator at 5° C in the presence of a few drops of toluene Either treatment resulted in the extraction of water-soluble pigments from the cells The cell debris was separated from the extracted pigments by centrifugation at 25,000*g*

Absorption spectra of cell suspensions were measured in a Cary recording spectrophotometer, using the opal glass technique of Shibata *et al* [6] to overcome the effects of scattering Absorption spectra of the extracted pigments were measured with a Beckman *DU* spectrophotometer

Attempts at chromatographing the pigments were made according to the procedure described by Swingle and Tiselius[7] and Haxo *et al* [8]

Absorption spectra of suspensions of intact cells of *Chroomonas* sp , *H virescens* and *C ovata* are shown in Figs 1*a* and 1*b* The absorption spectra of *Hemiselmis* and *Chroomonas* are different from those of any organisms previously studied, whereas the spectrum of *C ovata* resembles that of a blue-green alga containing phycoerythrin

Disruption of *H virescens* releases a blue pigment with a deep red fluorescence The absorption spectrum of this pigment is shown in Fig 2 This three-peaked absorption curve, with maxima at 645, 620–625 and 580 mμ, is different from that of any algal chromoprotein previously reported Attempts at resolving the pigment into components by chromatography have led to loss of most of the pigment on the column The portion recovered had the same absorption spectrum as the original material. Attempts at separation into sub-units by fractional precipitation with ammonium sulphate have been equally unsuccessful The blue pigment from *Hemiselmis* is thermolabile, non-dialysable, and precipitated by acetone or ammonium sulphate The few measurements which could be made on *Chroomonas* suggest that its blue pigment is similar to that of *Hemiselmis*

On disruption of the cells, a red pigment with orange fluorescence is released from *C ovata* The absorption spectrum of this pigment is shown in Fig 3 The peak at 565 mμ is reminiscent of C-phycoerythrin[8], but the shape of the curve is different, falling less sharply on the long-wave-length side than does C-phycoerythrin, and having a shoulder at 600 mμ Like the blue pigment from *Hemiselmis*, the red pigment of *Cryptomonas* is thermolabile, non-dialysable, and precipitated by acetone and ammonium sulphate at high concentrations Attempts at purification by chromatography on calcium phosphate gel led to decomposition of the pigment Chromatography on calcium carb-

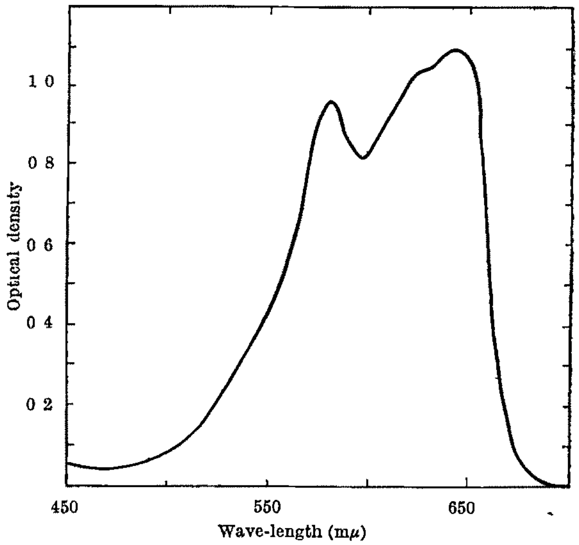

Fig 2 Absorption spectrum of blue pigment from *Hemiselmis virescens*

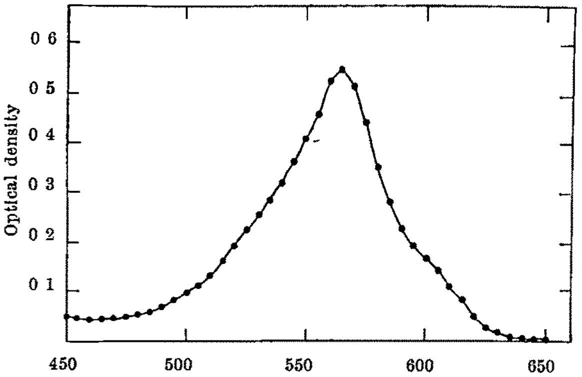

Fig 3 Absorption spectrum of red pigment from *Cryptomonas ovata*

onate was also tried, but the pigment passed through the column without being absorbed

The spectroscopic and other properties of the red and blue cryptomonad pigments are consistent with the conclusion that they are bilichromoproteins similar to, but not identical with, those found in the red and blue-green algae This conclusion is supported by some preliminary observation on the products resulting from hydrolysis of the proteins with hydrochloric acid as described by Ó hEocha[9] Some differences from the phycobilins of the red and blue-green algae must be noted, however The cryptomonad pigments are more labile under chromatography than phycobilins previously known, they require very high concentrations of ammonium sulphate to precipitate them, and they are quite resistant to hydrolysis by hydrochloric acid Studies by Haxo and Fork and by Ó hEocha and Raftery[2] have shown spectroscopically different chromoprotein pigments in other cryptomonads For example, *Rhodomonas lens* contains a red pigment resembling C-phycoerythrin, whereas another strain of *H virescens* yields a phycocyanin with only two absorption peaks

The possession of phycobilin pigments by members of the Cryptophyceae suggests a phylogenetic relationship among the cyanophytes, rhodophytes and cryptomonads, all of which possess these pigments It is possible that the ability to form large quantities of phycobilins arose more than once in evolutionary history, since by present evidence phycobilins are by-products of the biosynthetic pathway leading to the chlorophylls[10] However, in the absence of any evidence for a polyphyletic origin of these pigments, an attractive hypothesis is that the cryptomonads are the most archaic group of metaprotists, the survivors of the first organisms to make the transition from the mesoprotistan (red algal) level to the metaprotistan (flagellate) level, that is, from eukaryous organisms without vibratile organelles to those possessing pecilokonts ('true flagella') (Cf earlier papers[11] for discussion of these distinctions among the Protista)

We wish to thank the National Science Foundation of the United States for support, and Prof M Calvin and Dr O Holm-Hansen for the use of the Cary recording spectrophotometer

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Phycoerythrins and Phycocyanins of Cryptomonads

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The algal biliproteins, phycoerythrins and phycocyanins are found in the Rhodophyta and Cyanophyta[1] Mrs B T Hepper (personal communication, 1954) noted the similarity between the absorption spectrum of an aqueous extract of the marine cryptomonad *Hemiselmis rufescens* Parke[2] and that of C-phycoerythrin, characteristic of the Cyanophyta At her suggestion, we have examined this pigment in greater detail and extended the study to a number of other marine cryptomonads kindly provided by Dr Mary Parke, of the Marine Biological Association Laboratory, Plymouth

Wolken and Haxo in a personal communication to Provasoli[3] noted that the red pigment of the cryptomonad *Rhodomonas lens* Pascher and Ruttner had similar light-absorption characteristics to phycoerythrin

All the properties of the water-soluble pigments which we have studied indicate that they may be classified as phycoerythrins and phycocyanins Four of the six species examined contained phycoerythrin only, one appeared to contain a small amount of phycocyanin in addition to phycoerythrin and one gave phycocyanin only The latter differed in absorption spectrum from any phycocyanin previously reported

The cryptomonads were grown in 'Erd Schreiber' medium[4] in either 250-c c Erlenmeyer or 1-litre conical culture flasks in weak white fluorescent light at room temperature

The algae were harvested by centrifugation of the cultures at about 10,000 r p m and extracted with distilled water in the cold after grinding with pulverized glass The extracts were centrifuged and clarified by passage through 'Supercel' filter aid When sufficient material was available the biliproteins were purified by adsorption chromatography on tricalcium phosphate–'Supercel'[5,6]

The pigments were washed off the columns with phosphate buffer (c 0 025 M), pH 6 4, to which saline had been added to promote desorption The yield after chromatography was spectrophotometrically estimated at 40–60 per cent , the cryptomonad pigments are less stable than R-phycoerythrin, which gave about 75 per cent yield[6] The phycoerythrin of *H rufescens* was also purified by chromatography on 'Amberlite *IRC*-50' resin and eluted with phosphate buffer (0 6–1 0 M , pH 7 2)

The phycobilin chromophores of the biliproteins were prepared by concentrated hydrochloric acid hydrolysis for 20–30 min at room temperature[7]

Absorption spectra were determined with a 'Unicam' S P 500 spectrophotometer

Table 1 gives the absorption maxima of the total aqueous extracts, the chromatographically homogeneous phycoerythrins and phycocyanins, and their phycobilin chromophores The spectral and chromatographic evidence indicates that, with one exception, each of the algae examined contains only one biliprotein That *Sennia* sp contains a small amount of phycocyanin, in addition to phycoerythrin, is indicated by the slight peak at 620–630 mμ, sufficient material was not available for chromatographic analysis

Table 1 SPECTRAL CHARACTERISTICS OF CRYPTOMONAD BILIPROTEINS

Alga and Plymouth reference	Absorption maxima in the visible spectrum (mμ)		
	Total aqueous extract	Chromatographically homogeneous pigment (in buffer, *p*H 6 4)	Phycobilin (in acid chloroform)
Hemiselmis rufescens ("D")	555	556	576
Cryptomonas sp (No 23)	550	545	576
Rhodomonas sp (No 29)	550	545	576
Cryptochrysis sp (No 14)	555	554	—
Sennia sp (No 9)	545 620–630	—	—
Hemiselmis virescens (?) (No 157)	588 615	588 615	—

Phycoerythrin The visible absorption spectrum of chromatographically purified phycoerythrin from *Hemiselmis rufescens* (Fig 1) does not differ appreciably from that of the total extract The absorption curves of the orange-fluorescing phycoerythrins from other species were similar in shape but the maxima lay at somewhat different wave-lengths (545 and 554 mμ) However, the same phycobilin chromophore appears to be present in all the cryptomonad phycoerythrins hydrolysed (Fig 1, Table 1), both the free phycobilin and its zinc-complex have the same spectral properties as those obtained from R-, C- and B-phycoerythrins[7], with the exception of the 640 mμ peak of the zinc-complex, which may be due to an artefact

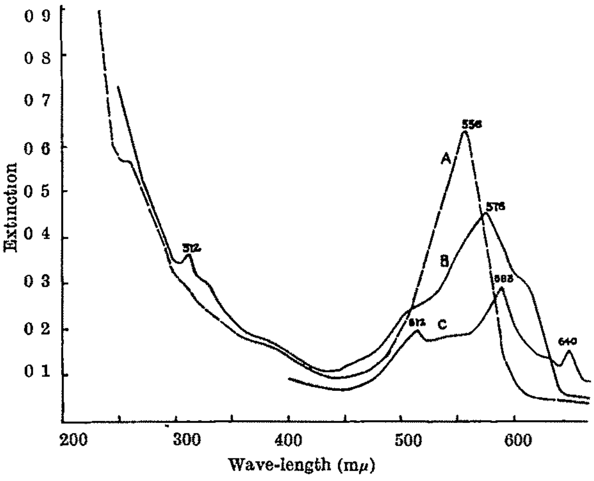

Fig 1 Absorption spectra *A* Phycoerythrin from *Hemiselmis rufescens* (in 0 025 *M* phosphate buffer, *p*H 6 4) *B* Phycobilin chromophore of *A* (in acid chloroform) *C* Zinc-complex of *B* (in chloroform)

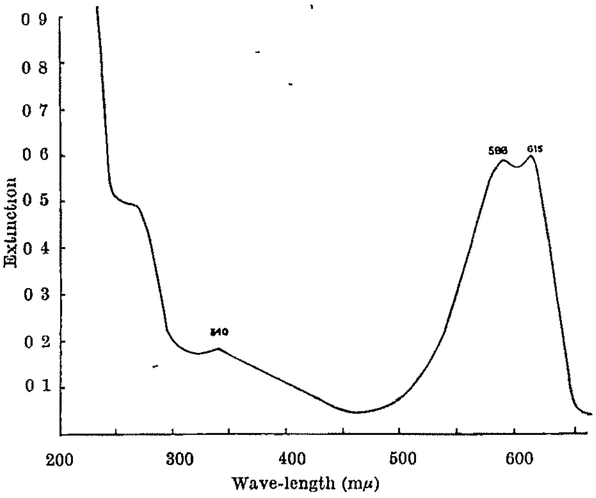

Fig 2 Absorption spectrum of phycocyanin from *Hemiselmis virescens* (0 025 *M* phosphate buffer, *p*H 6 4)

Higher concentrations of ammonium sulphate were required to precipitate the cryptomonad phycoerythrins than those of the other algal divisions, but their electrophoretic mobility was similar to that of R-phycoerythrin in acidic buffers However, at alkaline *p*H values *H rufescens* phycoerythrin moved toward the cathode on paper electrophoresis

Phycocyanin The absorption maxima of the blue-coloured red-fluorescing pigment of *Hemiselmis virescens* were at 588 and 615 mμ (Fig 2) The pigment appeared to be homogeneous, as fractionation could not be achieved by chromatography, paper electrophoresis, or ammonium sulphate precipitation The pigment was quite resistant to concentrated hydrochloric acid hydrolysis, but preliminary results point to the chromophore being a phycobilin

The results presented in this communication are essentially similar to those of Allen *et al* and of Haxo and Fork[8] They all point to the cryptomonad pigments being biliproteins related to those of the red and blue-green algae

The light absorption characteristics of the phycoerythrins present in five of the species examined resemble most closely those of C-phycoerythrin, the single absorption maximum of which can vary in position from 546 mμ (ref 9) to 552 mμ (ref 10) to 560, 563 and 565 mμ[6,7,11] The phycobilins are spectrally similar, but more detailed studies will be necessary before the exact structural relationships between the cyanophytan and cryptomonad phycoerythrins can be elucidated

The phycocyanins reported in the literature may be broadly classified as follows (approximate absorption maxima in brackets) R-phycocyanin (555 and 615 mμ), C-phycocyanin (615 mμ), allophycocyanin (650 mμ) The phycocyanin of the Plymouth strain of *Hemiselmis virescens* Droop (588, 615 mμ) differs from all these It also differs from that reported by Allen *et al*[8] for phycocyanin from the type strain (Millport No 64) of this alga (maxima at 580, 620–625, 645 mμ) The only other observed difference between these two strains is that the latter produces more carotenoid masses than the Plymouth strain (Mary Parke, private communication)

The cryptomonads (Cryptophyceae) have been generally placed in the algal division Pyrrophyta, which also includes dinoflagellates (Dinophyceae), the most characteristic pigment of which is the xanthophyll, peridinin[12]. In view of the present and related findings[8], the use of similarity in colour of cryptomonads and dinoflagellates as an argument for grouping them together, already suspect[13], would seem unjustified

We wish to acknowledge our sincere thanks to Dr Mary Parke, Plymouth, who provided the cryptomonad cultures and directions for their growth , and to the Chemical Society for a grant from the Society's Research Fund

Added in proof Careful chromatographic examination of extracts of all our phycoerythrin-containing cryptomonads has revealed the presence of small amounts of phycocyanin (λ_{max} c 635 mμ), when the algae were grown in a north window

Dr Michael Droop has kindly supplied us with a sample of the type-strain of *Hemiselmis virescens*, which we have grown under our culture conditions We have confirmed the findings of Allen *et al* [8] concerning the spectral properties of phycocyanin from this strain

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Photosynthetically Active Accessory Pigments of Cryptomonads

By Dr F T HAXO and D. C FORK

Division of Marine Biology, Scripps Institution of Oceanography, University of California, La Jolla

THE Cryptophyceae have attracted interest as a minor algal group of uncertain taxonomic affinities, notable for the varied coloration of its pigmented representatives[1] The isolation into laboratory culture of the red, marine cryptomonad *Rhodomonas lens* by L Provasoli[2] has prompted studies of the nature and function of its plastid pigments The results are communicated here in brief, together with those obtained afterwards with the brown-coloured flagellate, *Cryptomonas ovata* These and the chemical investigations by Allen, McLaughlin and Dougherty and by Ó hEocha and Raftery[3] on a greater variety of species, establish the common occurrence of phycobilin-like pigments within the cryptomonads and their role as accessory photosynthetic pigments

Cultures of *Rhodomonas lens* Pascher and Ruttner and *Cryptomonas ovata* var *palustris* Pringsh were provided by L Provasoli and Richard Starr, respectively Both organisms yielded dense cultures after 4–6 weeks when grown in synthetic liquid media (unpublished formulations of L Provasoli) at 20° C with continuous illumination of 50–100 ft -candles intensity The cells were harvested by continuous-flow centrifugation at 5,000 r p m

Extraction and purification of the water-soluble pigments were carried out in the cold at *p*H 6–7 The cells were ruptured by passage through a needle valve (French press) at 15,000 lb /sq in , and the homogenate was clarified by centrifugation at 144,000*g* for 1 hr or more The pigment of the brilliantly fluorescing supernatant was precipitated with ammonium sulphate, re-dissolved in dilute saline, and chromatographed on tricalcium phosphate, using the method of Swingle and Tiselius[4] and Haxo, Ó hEocha and Norris[5], but omitting diatomaceous earth, which adsorbed a portion of the pigment irreversibly The fat-soluble pigments residing in the particulate fraction were extracted with methanol at *p*H 8–9 and fractionated by column chromatography on polyethylene powder and conventional adsorbents. Spectral analyses were made with a Beckman *DU* spectrophotometer.

Photosynthetic action spectra of freshly harvested cells were measured polarographically at 20° C using Haxo and Blinks's method[6] The reaction vessel was modified, however, by recessing the platinum electrode to accommodate a 0 25-mm layer of suspended cells, horizontally oriented in the beam from the monochromator

The spectral similarity of centrifuged aqueous extracts of *R lens* to C-phycoerythrin was noted earlier by Wolken and Haxo (cf L Provasoli, ref 2). On chromatographic columns several diffusely adsorbed pink zones were observed, all of which gave similar spectra The principal fraction, eluted with 0 1 *M* phosphate buffer, had the following characteristics maximal absorption at 545 mμ and secondary peaks at 390 and 275 mμ , strong yellow fluorescence , non-dialysable ; precipitation from aqueous extracts upon heating, by addition of three volumes of acetone, and by saturated ammonium sulphate at 0° C , photolability moderate at 20° C , slight at 5° C

Chromatographically purified pigment from *C. ovata* showed similar solubility properties, but displayed a reddish-orange fluorescence and absorption peaks at 568 and 285 mμ The pigments of the two cryptomonads are therefore spectrally distinct. Their observed properties suggest that they are bilichromoproteins similar to, but not identical with, the single-peaked C- and B-phycoerythrins[7,8] Their spectral properties and possibly also their precipitation only at high ammonium sulphate concentrations are features which distinguish them from the known bilichromoproteins of red and blue-green algae.

Both cryptomonads yielded three chlorophyll fractions (absorption maxima in ether) chlorophyll *a* (*665*, 615, 577, 530, *430*, *410* mμ) , chlorophyll *c* (*633*, 581, *450* mμ) ; and an unidentified hypophasic component (*667 5*, 615, 576, 531, 500, 429, *412* mμ). The latter may be a degradation product of chlorophyll *a*, but it was not observed in similarly treated extracts of a dinoflagellate (*Gonyaulax polyedra*) or of brown algae (*Eisenia arborea* and *Macrocystis pyrifera*) The solubility and adsorption properties, and in particular the spectral properties (Fig 1) of the chlorophyll *c* from *R lens* and *C. ovata*, corresponded closely with our preparations of this pigment from the above-named reference sources Evidence for the presence of chlorophyll *c* in *C ovata* was recently obtained by French, Elliott and Allen (ref 9 and personal communication) from absorption spectra of intact cells

The carotenoid hydrocarbons of *C. ovata* included, as the major component, α-carotene (identity confirmed by co-chromatography with an authentic

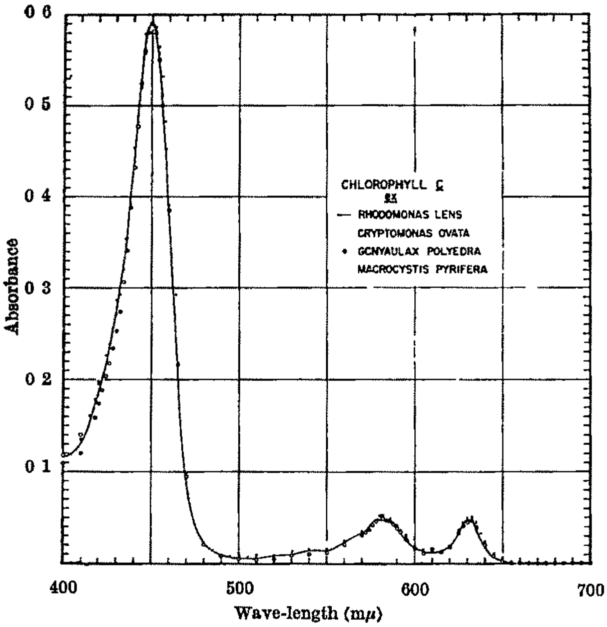

Fig 1 Absorption spectra in ethyl ether of chlorophyll *c* from *Rhodomonas lens*, *Cryptomonas ovata*, *Gonyaulax polyedra* and *Macrocystis pyrifera*

sample) and a less strongly adsorbed polyene (absorption maxima in hexane at 471, 442 and 418 mμ), probably ε-carotene The xanthophylls of *C ovata* were more abundant than the carotenes (ratio 2 4 · 1) The absorption spectrum and the partition behaviour of the principal xanthophyll corresponded closely to those of zeaxanthin, however, identity with the very similar pigment diatoxanthin was not precluded The poly-oxy carotenoids, peridinin and fucoxanthin, were not present in detectable amounts in extracts from either cryptomonad, although these pigments were readily isolated by the same procedures from reference sources

That the 'phycoerythrins' of both flagellates are effective sensitizers in photosynthesis is demonstrated by the photosynthetic action spectra and corresponding absorption spectra presented in Figs 2 and 3 Photosynthetic activity is highest in the middle of the spectrum (540–570 mμ) where the water-soluble pigments contribute most prominently to cell absorption A somewhat lower effectiveness for light absorbed by chlorophyll is indicated This situation is seen most clearly at wave-lengths beyond 660 mμ, where absorption may be attributed solely to chlorophyll

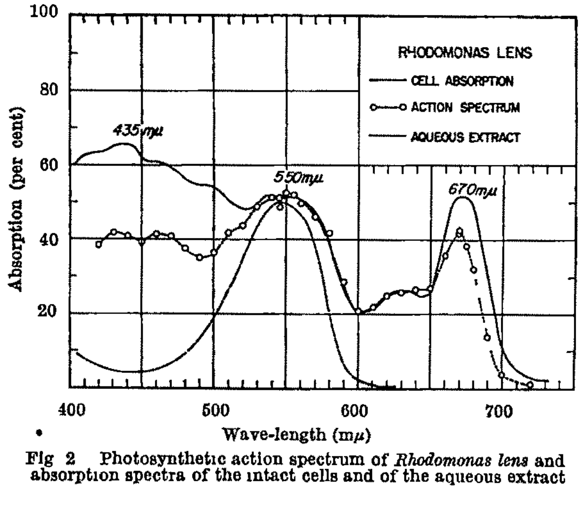

Fig 2 Photosynthetic action spectrum of *Rhodomonas lens* and absorption spectra of the intact cells and of the aqueous extract

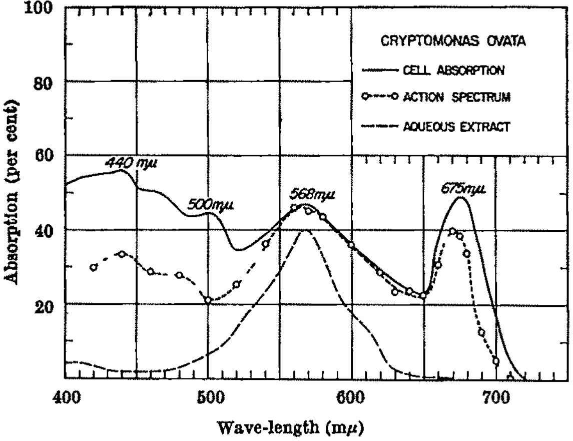

Fig 3 Photosynthetic action spectrum of *Cryptomonas ovata* and absorption spectra of the intact cells and of the aqueous extract

Previous work on the bilichromoproteins has been concerned mainly with those of red and blue-green algae, in which they function as accessory pigments to chlorophyll *a* alone[10] In the former group of algae, small amounts of chlorophyll *d* may also be present The cryptomonads now examined differ from other types of algae bearing phycobilin in that photosynthetically active bilichromoproteins are associated with chlorophyll *c* as well as chlorophyll *a* It is noteworthy in this connexion that the 'inactive chlorophyll' fraction of cryptomonads is small relative to that characteristically encountered in the Rhodophyta[6]

The evolutionary relationships of the cryptomonads remain unsettled, although Pascher[11] proposed that they are related to the dinoflagellates In this connexion, it is of interest to compare the plastid pigments of the cryptomonads and the dinoflagellates Both groups contain chlorophylls *a* and *c*, but these two chlorophylls also occur in diatoms and in the brown algae Peridinin, the characteristic carotenoid of dinoflagellates, was not detected in the cryptomonads that we have examined In further contrast, bilichromoproteins have not been detected in the dinoflagellates, although species with blue chromatophores[12] have not been examined in this respect. Available information, although limited, suggests that the cryptomonads possess a distinctive cor plement of plastic pigments

We are indebted to Nao Belser and William McCl for their assistance in certain phases of this study

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FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, November 23

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 5 p m —Mr Barrie E Juniper "Oxford University Tanganyika Expedition"

Institution of Mechanical Engineers, Education Group (at 1 Birdcage Walk, Westminster, London, S W.1), at 6 p m —Discussion on "Vibration Theory, Linear Systems and the subject 'Theory of Machines'"

Tuesday, November 24

Society for Analytical Chemistry, Physical Methods Group (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m —Mr R A C Isbell "The Design of Optical Instruments for Chemical Analysis"

Royal Aeronautical Society (at 4 Hamilton Place, London, W 1), at 7 p m —Prof D B Spalding "Heat and Mass Transfer in Aeronautical Engineering"

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W 1), at 7 p m —Mr N I Walker "Application of Instrumentation to Glass Melting Furnaces"

Radar and Electronics Association (at the Royal Society of Arts, John Adam Street, Adelphi, London, W C 2), at 7 30 p m —Prof H E M Barlow "Waveguides for Long Distance Communications" *

Wednesday, November 25

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 2 30 p m —Sir Christopher Hinton, K B E , F R S , and Sir William Holfrod "Power Production and Transmission in the Countryside—Preserving Amenities"

Geological Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p m —Mr L R Raymond "The Pre-Permian Floor beneath Billingham, Co Durham", Dr J.M Hancock "The Cretaceous System in Northern Ireland"

Institution of Electrical Engineers, Electronics and Communication Section (at Savoy Place, London, W C 2), at 5 30 p m —Dr R L Smith-Rose "Radio Aspects of the International Geophysical Year"

Institute of Physics (at 47 Belgrave Square, London, S W 1), at 6 p m —Mr J F Coales "Education for Automation"

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S W 1), at 6 p m —Prof A H Cottrell, F R S "The Effect of Nuclear Radiation on Engineering Materials" (Thomas Hawksley Lecture)

Society of Chemical Industry, Food Group (at 14 Belgrave Square, London, S W 1), at 6 15 p m —Mr G E Moss "Fortuitous Corrosion Inhibitor in Biscuit Mixes", Mr P G Seary "Recent Developments in Produce Pre-packaging"

Society for Analytical Chemistry (joint meeting with the Pharmaceutical Society of Great Britain, at 17 Bloomsbury Square, London, W C 1), at 7 30 p m —Meeting on "Methods of Assays of Capsicum, Lonchocarpus and Rauwolfia"

Thursday, November 26

Institute of Marine Engineers (joint meeting with the Society of Naval Architects and Marine Engineers, at the Memorial Building, 76 Mark Lane, London, E C 3), at 3 p m —Mr C C Pounder "Human Problems in Marine Engineering", at 5 30 p m —Mr J J Zrodowski and Mr H C Andersen "Co-ordinated Alignment of Line Shaft, Propulsion Gear and Turbines"

Institution of Electrical Engineers (at Savoy Place, London, W C 2), at 5 30 p m —Mr T R Manley, Mr K Rothwell and Mr W Gray "The Application of Low-Pressure Resins to some High-Voltage Switchgear Designs"

Institution of Mechanical Engineers, Applied Mechanics Group (at 1 Birdcage Walk, Westminster, London, S W 1), at 6 p m —Discussion on "The Application of Creep Results to Engineering Design"

Royal Aeronautical Society (at Church House, Westminster, London, S W 1), at 6 p m —Prof H Schlichting "Some Developments in Boundary Layer Research in the Last Thirty Years" (Third Lanchester Memorial Lecture)

Thursday, November 26—Friday, November 27

Institute of Petroleum (joint meeting with the Corrosion Group and the Chemical Engineering Group of the Society of Chemical Industry, in the Grand Council Chamber, The Federation of British Industries, 21 Tothill Street, London, S W 1), at 9 30 a m daily—Joint Symposium on "Corrosion Problems of the Petroleum Industry"

Friday, November 27

Royal Aeronautical Society (at 4 Hamilton Place, London, W 1), at 7 p m —Dr D R Walkie "Man and an Aero Engine"

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m —Dr P T Haskell "Research in the War against Locusts"

Friday, November 27—Saturday, November 28

Botanical Society of the British Isles (at the Lecture Hall, The British Academy, Burlington House, Piccadilly, London, W 1)—Darwinian Centenary Conference

British Society for Immunology (at the Wellcome Foundation, 183 Euston Road, London, N W 1)—Symposium on "Persistence of Immunity" Chairman Dr C H Andrewes

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

James Morrison Research Fellow (not necessarily medically qualified), to pursue full-time research into the treatment of malignant disease by radiotherapy or other methods, at or in association with the David Morrison Research Department of the Sheffield National Centre for Radiotherapy—The Registrar, The University, Sheffield (November 21)

Research Fellow (physics graduate), to investigate the radiation from gas discharges—The Registrar, The University, Sheffield 10 (November 21)

Research Fellow (post-doctoral chemist or biochemist, with suitable interest and experience) in the Department of Chemistry of the Faculty of Science, to work on the synthesis of nucleotide analogues and the study of their metabolism—The Registrar, The University, Manchester 13 (November 21)

Plant Taxonomist (honours graduate majoring in botany, or equivalent qualifications, with some research experience in taxonomy, preferably in tropical plants) in the Division of Land Research and Regional Survey, Commonwealth Scientific and Industrial Research Organization, Canberra, Australia, to undertake taxonomic research essentially with New Guinea flora, by way of revision of selected group, in collaboration with an ecologist and forest botanist, in the identification of important species—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting Appointment No 570/76 (November 27)

Fellow (honours graduate in science or engineering with postgraduate research experience involving microwave techniques in the field of paramagnetic resonance, particularly as applied to masers) in Radio Astronomy in the Division of Radio Physics, Commonwealth Scientific and Industrial Research Organization, Canberra, Australia—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting Appointment No 780/216 (November 28)

Chair of Chemical Engineering—The Registrar, University College, Singleton Park, Swansea (November 30)

Lecturer in Mathematics at Palmerston North University College (Victoria University of Wellington), New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (November 30)

Lecturer or Senior Lecturer in Preventive Medicine at the University of New England, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (November 30)

Lecturer in Civil Engineering—The Registrar, University of Adelaide, Adelaide, South Australia (December 7)

Senior Research Fellow in the Institute of Education—The Registrar, The University, Leeds 2 (December 7)

Assistant or Associate Professor of Applied Mathematics—The Chairman, Department of Mathematics, McMaster University, Hamilton, Ontario, Canada (December 10)

Senior Tutor/Lecturer in Psychology at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (December 11)

Lecturer in Geology and/or Geophysics at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (December 12)

Chair of Philosophy—The Registrar, The University, Leeds 2 (December 31)

Professor of Applied Mathematics—The Secretary and Registrar, University College of North Wales, Bangor (January 1)

Director of the Institute of Education and Professor of Education—The Registrar, The University, Leeds 2 (January 15)

Biologist (with a good honours degree in zoology and/or botany, preferably a knowledge of both subjects and some postgraduate experience) with the Fauna Research Unit, Kenya, to carry out research on Kenya fauna to provide data for the building up of life-tables, details of feeding habits, enemies, predators and diseases—The Director of Recruitment, Colonial Office, London, S W 1, quoting BCD 61/7/09/T

Biologist (with a university degree in science, including botany and zoology, with preferably a diploma in education and/or teaching experience) in the Department of Agriculture, Uganda, to teach scientific subjects in an agricultural course of the standard of the Diploma course of an agricultural college in the United Kingdom—The Director of Recruitment, Colonial Office, London, S W 1, quoting BCD 63/9/030/T

Botanist (Plant Pathologist) (with a good honours degree in botany or agricultural botany, and at least two years postgraduate experience in plant pathology) in the Department of Agriculture, Uganda, to diagnose the causes of crop diseases and to recommend control measures, and to assist with the breeding of disease-resisting crops—The Director of Recruitment, Colonial Office, London, S W 1, quoting BCD 63/9/02/T

Chemists, Senior Scientific Officer or Scientific Officer grade in Research and Development Establishments of the Ministry of Aviation, mainly Southern England, offering a wide range of problems including high polymers, safety glass and ceramics, electro-chemistry, propellants based on polymeric fuels, combustion reactions, reaction kinetics, chemical engineering, initiation and detonation of high explosives, corrosion, and analytical methods—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting Ref F 647/9A/AA

ENTOMOLOGIST (Scientific or Senior Scientific Officer grade, with a good honours degree in zoology, with postgraduate training or experience in entomology) at the West African Cocoa Research Institute, Ghana, for research on insect pests of cocoa—The Director of Recruitment, Colonial Office, London, S W 1, quoting BCD 197/200/02/T

PRINCIPAL OF THE ROYAL TECHNICAL COLLEGE OF EAST AFRICA, Nairobi, and **PRINCIPAL-DESIGNATE** of the proposed University College into which the Royal Technical College is to be transformed—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1

SENIOR AGRONOMIST (with a degree in agriculture or in natural science with a postgraduate diploma in agriculture and considerable experience in field experimentation, preferably with perennial tree crops) at the West African Cocoa Research Institute, Ghana, to take charge of the Agronomy Section and co-operate with senior specialist officers in the field experimental work of the Institute—The Director of Recruitment, Colonial Office, London, S W 1, quoting BCD 197/200/010/T

SOIL CHEMIST (with an honours degree in chemistry or in natural science including chemistry, and at least two years postgraduate training or experience as a soil chemist) at the West African Institute for Oil Palm Research, Nigeria, for the study and analysis of soil types with a view to improving soil conditions—The Director of Recruitment, Colonial Office, London, S W 1, quoting BCD 197/199/016/T

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

London and Home Counties Regional Advisory Council for Technological Education Bulletin of Special Courses in Higher Technology including Management Studies and Commerce, 1950–60 Part 1 Autumn Term Pp 136 (London London and Home Counties Regional Advisory Council for Technological Education, 1959) *3s 6d* [249

Ministry of Supply Reports on Plastics in the Tropics No 11 Cast Acrylic Sheet Pp 39 (London H M Stationery Office, 1959) 5s net [249

The Royal Observatory Edinburgh Report of the Astronomer Royal for Scotland for the year ending 1959, March 31 Pp 8 (Edinburgh The Royal Observatory, 1959) [249

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Editorial and Publishing Offices of "NATURE"
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ST MARTIN'S STREET, LONDON, W C 2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare London

Annual subscription £7/15/–, payable in advance,
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Telephone Number Holborn 4743

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THE DEVELOPMENT OF PUBLIC SERVICES IN A MODERN DEMOCRACY

TWO of the most valuable chapters in Dr Brian Chapman's recent book, "The Profession of Government" (London George Allen and Unwin, Ltd , 1959 28s net), are those in which he discusses the public service trade unions, and the relations between public officials and the public The two subjects are closely connected, and in the compass of little more than a score of pages Dr Chapman focuses attention on some problems of vital importance to the functioning of a democracy, of which there is little evidence that administrators, professional associations or the public generally are aware Nevertheless, upon the effective solution of such problems the wise use of scientific and technical resources and the very possibility of creative leadership, in the service of the State or elsewhere, may largely depend

Dr Chapman goes unerringly to the root of the problem with public service trade unions All the evidence points to the truth that people employed in government service tend to become not only self-governing but also self-employed Moreover, the strength of these unions is in the lower ranks, and while in these grades parity with outside employment has been maintained, financially there is a genuine conflict of interest between the various grades of the public service Unions representing the lower- and middle-grade officials will not accept a policy of discriminatory rises for particular grades, and for this financial reason alone, the higher public officials insist on special representation

Now, while the European public services have acquired most of the characteristics of a profession, even for the higher Civil Service in Britain there is no recognized professional qualification or any general acceptance that the profession should have a monopoly of government The acquisition of a recognized public status and the growth of professional training schemes in the Civil Service only partly compensate for this lack of a professional qualification Furthermore, the professional ways of thought of public officials, more especially the senior officials, are distinctive, imposed on them by the nature of their duties , and while generally such officials are naturally affected by the way the public regard them and, in consequence, by the underlying philosophy of society and the State reflected in a country's view of public administration, Dr Chapman's comparative survey points to a surprising similarity in attitudes in senior public officials in all European public services

Dr Chapman emphasizes the dependence of these attitudes on the nature of the official's duties and not on his social class In all the countries covered by him, the public official is in social terms a typical member of the middle class , but there are few reliable statistics on the social origins of public officials in Western Europe and it is not possible to prove that public service is a factor in social mobility It is certain, however, that social class in the public service does not work in reverse The sons of members of the administrative class are practically never found lower down the scale , unless they can join at their father's level, they enter another profession It is also clear that the working class and the agricultural population are both under-represented at all levels of the administration in comparison with their proportion in the population

Nevertheless, Dr Chapman's survey suggests that this question of social origin is relatively trivial, in comparison with the decisive influence of professional duties on their attitudes Indeed, social class and their duty to society, as well as the nature of their work, alike make senior officials conservative, and their first preference is to keep the peace and maintain the *status quo* In spite of this, they sympathize with efforts to remove the worst or most noticeable abuses in the fields of government which are their direct concern Dr Chapman points out that they, frequently more so than politicians, are aware of the black spots of society, even though their knowledge may be second-hand, and that this instinct for improvement has been responsible for many minor social and industrial reforms throughout Europe, particularly in the newer fields of government Most frequently, however, the instinct to improve is confined to the official's special field

It is inherent in this that senior officials should incline to believe that they are more disinterested, intelligent and far-sighted than other people engaged in government, and this is due not so much to authoritarianism as to the distrust of the professional for the enthusiastic amateur Again, awareness of public responsibility and of the impossibility of full impartiality and equality of treatment can also lead to a clash between professional and amateur, and to divergence between official and public The official is aware that he has to deal with a world that is neither efficient, rational nor equitable, and distrusts the claim that the public has an inalienable right to efficiency, impartiality and rationality He is also better aware than the public of inconsistencies which may mar their mutual relations

All this bears profoundly on the two questions which Sir George Schuster discusses in his review of the working of the National Hospital Service in Britain, entitled "Creative Leadership in a State Service"* Can a State-directed service be an instrument of dynamic progress and provide scope for individual enterprise and initiative ? Can State-directed 'welfare' measures produce true welfare—that is, welfare judged according to a standard of values appropriate to a modern society ? These questions, however, may be considered in the light of three major points which Dr Chapman makes as the outcome of his review of Western Europe as a whole.

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* Creative Leadership in a State Service a General Survey (Hospitals and the State Hospital Organization and Administration under the National Health Service, Sixth and final Research Paper) Pp iii+80 (London Acton Society Trust, 1959) 4s

First, in every country the increase in public services has not been accompanied by sufficient serious thought as to the best way of absorbing them into the structure of the modern State The haphazard creation of semi-public, public, quasi-private and partly autonomous bodies complicates law, operation and control Secondly, clarification in this field might help to disentangle some of the more acute problems of public service law There is no sensible reason, Dr Chapman suggests, why a postman should be a Civil servant and a gas inspector or railway driver should not Nor is there any serious reason why the vast mass of manipulative, clerical or even executive staff employed in public administration, whose duties are exactly comparable with those in private employment, should not be engaged on private law contracts A much more vigorous distinction in public administration between public officials and private law employees would both simplify public service law and permit an element of flexibility in personnel matters which is lacking in many countries, and also allow the general unification of the public services to be considered seriously This is particularly important at the higher levels, where it should promote a proper balance between administrators, managers and technologists, and remove some of the anomalies which disturb the Institution of Professional Civil Servants It might well be reconsidered whether the chemist, the physicist, the engineer, for example, engaged on professional duties in the Government service, need necessarily be a Civil servant unless those duties include public administration

Thirdly, Dr Chapman remarks that the recent awareness of the need for better government public relations has gone no further than communicating to the public what the public service concerned is doing, rather than why it is doing it This is an essential to informed public discussion, but in his reasoned attack on the secretiveness of British Government methods, Dr Chapman is too concerned with the negative effects of secrecy to emphasize the positive contribution of informed discussion to the functioning of democracy In Western democratic theory, government is the task of representatives of the electorate, and no growth in the complexity of the tasks of government can make government the task of a profession , it can only emphasize the responsibility of the professional administrator for seeing that the implications and consequences of particular decisions and policies are clearly understood by the elected representatives

The relevance of Dr Chapman's observations and suggestions to the problem of creative leadership which Sir George Schuster discusses in the context of the National Health Service in Britain is apparent from the start of Sir George's analysis That analysis follows on a general survey of hospital organization and administration under the National Health Service made by the Acton Society Trust, which vindicated the Government's original purpose to allow the fullest possible decentralization of the Hospital Service While this should be maintained, the Acton Society Trust points out that the Ministry is still left with a responsibility it cannot abdicate—that of giving inspiring leadership and guidance, interpreting the lessons of decentralized experience, and involving national resources for dealing with the problems that can only be effectively handled on a national basis In particular, the Trust's survey led to the conclusions that not enough had been done to study and interpret current experience , that a frequently changing junior political Minister is ill-placed to satisfy the need for continuous inspiring leadership in a great operating service , that the Ministry as at present organized does not provide a staff containing enough men with the right kind of knowledge based on practical experience in the field , that this staff is itself hampered by lack of an adequate statistical and intelligence service, and that the Ministry's advisory bodies cannot fill the gap

Sir George Schuster begins with Mill's prescription—the greatest dissemination of power consistent with efficiency but the greatest possible centralization of information and diffusion of it from the centre, and with Mill's dictum that a Government cannot have too much of the kind of activity which does not impede but aids and stimulates individual execution and development In emphasizing, however, the intensely human character of a health service and the large number of voluntary unpaid members concerned in its control, Sir George directs attention to two further questions which arise out of those to which he was asked to give special attention First, how—by what working methods and arrangements—can the preservation of the voluntary spirit of service which is embodied in the boards and committees of management be most effectively combined with adequate power for the Minister to discharge his responsibility to Parliament for ensuring efficiency and economy in the expenditure of public money ? Secondly, how can the professional freedom of medical practitioners and surgeons, on whose skill the work of the hospital service ultimately depends, be reconciled with the just claims of public authority ?

Obviously, these are essentially the questions that arise in regard to public expenditure on research and on the universities, and the answers Sir George Schuster suggests are of great interest to those concerned with the functioning of the University Grants Committee, public accountability in the nationalized industries and the deployment and balance of the national effort in scientific and industrial research and the control of expenditure in that field They are questions of far-reaching importance which should be a prime concern of the newly appointed Minister with special responsibility for scientific effort in Britain Moreover, while Sir George Schuster does not deal to any extent with the question of professional freedom, he has raised a general issue which demands the attention of professional bodies generally, and the importance of which in its broadest context has also been admirably stated by Sir Solly

Zuckerman in his recent address (see *Nature*, July 18, p 135) delivered at the California Institute of Technology

It is no disparagement of the importance of the National Health Service to suggest that Sir George Schuster's pamphlet is of even wider public interest in the context of the problem of government generally, the place and use of the expert in public affairs, the responsibilities of professional organizations and the functions and staffing of the Civil Service Like Dr Chapman, he displays issues where fresh thought is urgently required, practices which require critical and independent examination, and preconceived ideas and even traditions which should be challenged It is to be hoped that the place of his pamphlet in the survey of the National Health Service made by the Acton Society Trust will not lead other professional associations, or indeed the scientist and technologist generally, to miss the challenge to creative leadership which he offers to them no less than to the medical profession itself

BRITISH INDUSTRY

The Structure of British Industry

A Symposium Edited by Duncan Burn Vol 1 Pp xvii+403 45*s* net Vol 2 Pp xii+499 50*s* net (National Institute of Economic and Social Research) (Cambridge At the University Press, 1958)

FOR a long time the best general account of the main British industries in a single book has been Prof G C Allen's famous work, "British Industries and their Organisation", first published as long ago as 1933, though modernized in successive editions since The two volumes here under review constitute, therefore, the first new major attempt for a long time to provide something which, in principle, every British student of economics (and many overseas students) would like to have

As a new standard text-book and work of reference, this book has very great strength, but also, inevitably some weaknesses Its strength is that it calls upon an extremely able team of writers, many of them fresh from, or still engaged in, the task of writing larger monographs on the industries which they here discuss , the rest, who have made investigations for the sole purpose of their contributions to this symposium, remarkably well-selected and successful Its weakness is that it lacks the uniformity which can be achieved by a single author, asking roughly the same questions about a number of industries Apart from setting out the facts of size and number of firms, the different contributors adopt a variety of approaches which makes the editor's gallant effort to treat some matters of general interest in his final chapter a difficult one The student may also find the size and cost of this important work formidable

It would be wrong, however, to judge it merely as a text-book It is an important fact about economic studies that in the past decade or two, while at their theoretical end they have been accused of becoming more difficult for the practical man to understand, they have undeniably gained enormously in realism through economists consorting with practical men, either as Civil servants or as students of industrial problems in the field No one man can nowadays attain to comprehensive first-hand knowledge of a wide range of industries, as Alfred Marshall was able to seventy years ago—hence the necessity for a symposium—but the intimacy of the knowledge attained by the contributors, and the fundamental nature of the questions which some of them attempt to answer on such matters as pricing policy, are evidence of the increased penetration of economists generally into the realities of industrial life

A list of the industries dealt with shows the wide scope of these volumes agriculture, building, road and rail transport, coal, oil, chemicals, steel, building materials, machine tools, motors, aircraft, shipbuilding, electronics, cotton and rayon textiles, woollen and worsted, man-made fibres, pottery, pharmaceuticals, and cutlery It suggests, too, the variety of different 'atmospheres' to be dealt with, ranging from those dominated by State policy, as in the case of agriculture and aircraft production, to the predominantly private commercial atmosphere of, for example, the pottery industry , or from ferments of technological change, as in electronics or pharmaceuticals, to the static environment of wool textiles It need scarcely be said that the nature, possibility, and meaning of competition vary enormously from one industry to another The more closely one looks at most industries (even those which are in some sense the most 'competitive'), the further they appear to lie from the old model of 'perfect' competition between firms making exactly similar products The nearest simple model of wide application, indeed, would seem to be that of 'oligopolistic' competition, between firms which compete directly (or not quite directly) with a fairly small number of others—though with the important reservations that 'potential' competition, often from users of the product who might turn to manufacturing it themselves, is frequently just round the corner, and that the weapon of competition is increasingly often an improvement in design rather than a reduction in price. Nearly everywhere there is some evidence of increasing concentration, but in very many places the small firm is remarkably viable, not by any means always for the same reason Where concentration has gone so far as to create monopoly power, it becomes very evident that this power, though it may not be harmless, is subject to a variety of checks, quite apart from those imposed by legislation The case of coal, where absolute monopoly is itself the product of legislation, shows how powerful the restraint imposed by competition from quite different products can be

The question how far the structure of British industry conduces to high and increased efficiency is one which, again, admits of no simple answer The very general impression, indeed, is that the adjustments of the past twenty years have been made with reasonable smoothness and with gains of efficiency which are often striking This, however, should not lead the reader into complacency The contributors to this work have the relatively pleasant task of portraying British industry on the favourable wicket of expansion in the national economy and in world trade It is a very different story from the agonizing chronicle of difficult contraction in so many of the basic industries between the Wars It may be as well to reflect that, while we may hope never again to see general stagnation of the economy or a major depression in its total activity, we have given a number of hostages to fortune in, for example, motors and shipbuilding, which may find how much more difficult it is to be progressive in adversity than in prosperity

A J Brown

TURNING POINTS IN PHYSICS

Turning Points in Physics

A Series of Lectures given at Oxford University in Trinity Term 1958. By R. J. Blin-Stoyle, D. ter Haar, K. Mendelssohn, G. Temple, F. Waismann and D. H. Wilkinson. (Series in Physics.) Pp. v+192. (Amsterdam: North-Holland Publishing Company; New York: Interscience Publishers, Inc., 1959.) 20*s*.

DURING Trinity Term, 1958, a series of lectures was organized by the Reader in the Philosophy of Science and the Lecturer in the History of Science in the University of Oxford. The lectures, collected in this volume, are: (1) "The End of Mechanistic Philosophy and the Rise of Field Physics", by Dr. R. J. Blin-Stoyle; (2) "The Quantum Nature of Matter and Radiation", by Dr. D. ter Haar; (3) "Probability enters Physics", by Dr. K. Mendelssohn; (4) "From the Relative to the Absolute", by Prof. G. Temple; (5) "The Decline and Fall of Causality", by F. Waismann, and (6) "Towards New Concepts: Elementary Particles", by Prof. D. H. Wilkinson. The audience to whom they were originally addressed was composed of philosophers and scientists who were not physicists. The publishers suggest that they can be understood by laymen; I have the word of an historian colleague, who recommended the book with great enthusiasm for the general library, that this is so. He had some reservations, it is true, about grasping all the points raised; and it is not exactly light reading, even for the scientist. As an account of the origins and development of the present state of theoretical physics it is most stimulating; and to be able to communicate so much of the physicist's outlook at a non-specialist level is a magnificent achievement.

The title "Turning Points" is itself significant. Thirty or forty years ago classical physics was spoken of in rather dismal terms of 'downfall'; by inference, the supplanting modern physics was undergoing uplift—and it apparently did, quite out of this world. But the outcome of all this has not been depression or exaltation; nothing less than a complete re-orientation of all our ideas has been necessary, and this turning has not really been a sudden event. As the first lecture points out, the fulcrum was effectively set up by Faraday; and the statistical approach goes back nearly as far—but applied only to classical particles. The quotation from Niels Bohr—"My method is to try to say what I cannot say, because I do not understand it"; Dr. Waismann's statement that quantum physics presents a strong case against traditional logic; and Prof. Wilkinson's remark that the first stumbling block for people who want to understand the elementary particles is that some of the things they learn run counter to common sense, between them emphasize the kind of turning that is demanded. In the macroscopic world of everyday life, we can 'understand', use classical ideas, relate matters as 'cause and effect', work to the rules of logic, and be guided by common sense. In the microscopic world of atomic physics, none of these things can happen. The physicist has to live a life of double-dealing between two worlds—observing with macroscopic apparatus, and interpreting in terms of microscopic concepts which have no counterparts in ordinary life, either in essence or in behaviour. Each of the lectures shows clearly the terms of reference within which modern physics operates.

Rule out causality, mechanical particles, identifiable individual particles, and the appeal to analogy taken from everyday life, and what is left of the microscopic world except concepts that can only be handled as mathematical abstractions? This question, which is the real difficulty facing the ordinary reader (and most of us older physicists as well), is squarely met in the contributions of Prof. Wilkinson and Prof. Temple. The answer is, general invariance or symmetry or conservation conditions, and 'properties' (if that is the term) to which such conditions can apply—such as Newton's third law of motion (Temple) or the conservation of isotopic spin (Wilkinson), which seem indeed to have much in common.

Illustrations and examples strike a fresh and original note. The derivation of the Lorentz transformation (Temple) is neater and simpler than that in the text-books. The conflict between causality and the uncertainty principle (Waismann) is illustrated by idealized experiments, and numerous examples of the application of the principle are given. The account of the elementary particles (Wilkinson) is both up to date in content and superb in its clarity; the author does not, of course, lament that physicists are large compared with m_e, and long-lived by K-meson standards—but he mentions that this immense difference in scale prevents us from even being able to describe the microscopic world in ordinary language at all. The lighter touches and personal reminiscences that drop into place here and there suggest that the authors were thoroughly enjoying their task: they must have done, to be able to accomplish it so brilliantly. G. R. Noakes

CATALYTIC PROCESSES AND PETROLEUM

Catalysis

Edited by Prof. Paul H. Emmett. Vol. 6: Alkylation, Isomerization, Polymerization, Cracking and Hydroreforming. Pp. vi+706. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1958.) 156*s*. net.

THIS volume is the penultimate one in this very comprehensive series; it deals with the catalytic processes that have now such an important place in the petroleum industry. The editor is to be congratulated on this further stage of his monumental task and in particular on achieving a very reasonable uniformity of treatment in the six 'chapters' written by eleven authors. Each chapter forms a clearly defined section dealing with an important refinery operation involving catalysis and comprising alkylation (with 59 references), isomerization (322 references), polymerization of olefines (212 references), catalytic cracking (126 references) and reforming (164 references), together with a chapter on the mechanism of polymer formation and decomposition (374 references). The large number of references makes the volume a valuable starting point for further study, particularly to chemists entering the petroleum and petrochemicals field. At the same time the authors have accepted the responsibility of surveying this mass of literature and presenting it as a coherent account and not simply as a collection of abstracts.

Earlier volumes in this series dealt, of course, with the fundamentals of catalysis, so that the authors here are free to deal with the more specialized and practical aspects This still leaves a large field to be covered and in most cases the authors set clearly defined limits to the subjects they discuss

Alkylation is dealt with in a clear and concise manner, and the comment in this chapter that "the development of a body of knowledge in alkylation embraces in chronology the development of highly precise analytical distillation methods and spectroscopic identification methods for hydrocarbons" can apply to each chapter in turn It is interesting, though possibly fruitless, to speculate on the course of events if our modern techniques of hydrocarbon analysis had been available to the pioneers in this field

In the chapter on isomerization, a much more complete treatment is attempted under the headings "General Aspects and Mechanisms", "Kinetics" and "Equilibria" The treatment is very systematic and will be of particular value to research workers entering this field It is irritating, however, to find bracketed explanations such as "BF_3 (boron trifluoride)" and even "I_2 (iodine)" in a book of this type The chapter on mechanisms of polymer formation and decomposition follows, its scope being clearly defined and topics such as polycondensation, co-polymerization and hydrolytic and enzymatic cleavage reactions are included This is an excellent survey of the specified fields Polymerization of olefines is the subject of the next chapter, the presentation being limited to liquid polymers only, ranging up to lubricating oils and viscosity index improvers After an excellent discussion of the thermodynamics and mechanisms, commercial processes are dealt with in moderate detail The behaviour of pure hydrocarbons is the main theme of the chapter on catalytic cracking, the commercial processes being discussed only briefly This again is a necessary limitation in such a wide field A list of twelve phenomena is given, which it is suggested an acceptable theory of catalytic cracking should explain The poisoning action of nitrogen bases, a discussion of which immediately precedes the list, might well have been added to it The final chapter, on catalytic reforming, includes a good deal on the commercial processes and is again a valuable survey

The printing and diagrams are up to the high standard one expects, and the volume will certainly join the others of the series as an important contribution to the literature of chemical industry in the widest sense DAVID M WILSON

SEX ON THE FARM

Reproduction in Domestic Animals
Vol 1 Edited by H H Cole and P T Cupps Pp xv+651 (New York Academic Press, Inc, London· Academic Press, Inc (London), Ltd, 1959) 14 50 dollars

THIS book, when the second volume is published, will have to stand comparison with such well-known treatises as "Allen's Sex and Internal Secretions", a third edition of which is in preparation, "The Hormones", edited by Pincus and Thimann, and, above all, "Marshall's Physiology of Reproduction", publication of the third edition of which began in 1952 and is not yet complete

The present volume opens with two chapters on the anatomy of the male and female reproductive organs and is thereafter almost wholly concerned with the female There are four chapters, three of which are of a fundamental nature, dealing with the role of various hormones and of the nervous system in reproduction After five chapters describing the œstrous cycle of farm animals and the bitch (apparently the cat is not considered a domestic animal), fertilization, implantation, the physiology of the placenta and pregnancy, and parturition are covered in four chapters The volume ends with a chapter on lactation

In the space available it is impossible adequately to write a critical appreciation of so important a book, all that can be done, at the risk of appearing invidious, is to refer to those topics which particularly interest the reviewer He well remembers the absorbing interest with which he read in 1939 C G Hartman's outstanding chapter in "Sex and Internal Secretions" (second edition) Does the present volume contain a chapter comparable with this? This is scarcely to be expected since the power to write so vividly is unfortunately rare Perhaps C W Emmens's contribution on the role of the gonadal hormones in reproduction comes closest, for it is written in a flowing style and deals lucidly with a complicated subject Miriam E Simpson gives an authoritative and well-written account of the pituitary and other gonadotrophins, though her treatment of the subject might appear to be orientated towards man rather than farm animals C W Turner's chapter on the thyroid, adrenal cortex and posterior-pituitary hormones is something of a mixed bag, heavily over-shadowed by a discussion of practical applications of thyroid physiology in the domestic fowl and farm animals, a subject which might well have been assigned a chapter on its own The adrenal cortex and posterior-lobe hormones could easily have been expanded to separate chapters T J Robinson's contribution is noteworthy for an interesting and largely first-hand account of how the œstrous cycle of the ewe can be manipulated hormonally with the view of increasing fertility, it includes a short section on the 'doe' which, despite the "Shorter Oxford English Dictionary", turns out to be the female goat The brevity of this section reflects the paucity of experimental work on this species and it is the more surprising that a ten-year-old paper by the reviewer and his colleagues on out-of-season breeding was overlooked J Meites contributes a comprehensive review of mammary physiology with much of which the reviewer has little quarrel, though two points merit mention Even considering that the chapter must have been written nearly two years ago, it is surprising to learn that somatotrophin has no major role in mammary growth, and also to see cogent evidence for a role of oxytocin in the release of prolactin dismissed so summarily

A book of this nature must be considered as a whole rather than as a collection of isolated essays, and if it is to be successful, the editorial guiding hand must be all-pervading, if unobtrusive One criticism of the present book is that there is too little evidence of editorial co-ordination For example, posterior-pituitary hormones, principally oxytocin, are dealt with in several chapters but with little cross-referencing, the same applies to relaxin The value of the book to the reader would have been much enhanced had adequate cross-references been given in these and many other instances A number of other blemishes could have been eliminated by sterner editorial action There are infelicities such as the use of "beef" and "pork" to describe pituitary glands from the ox and pig (yet "mutton" is not used for sheep pituitaries, as it should have been for consistency), and the widespread use of the inept term "let-down" which the reviewer thought he had knocked out twelve years ago, but which has persistently refused to lie down There are some inconsistencies such as the use of "dog" rather than "bitch", while the females of the ox, horse, sheep and pig are called "cow", "mare", "ewe" and "sow" Bibliographical errors are also more frequent than they ought to be, particularly in Chapter 7 British readers are by now inured to what seems to be becoming standard American practice in the use of prepositions (two of the more startling examples being "identical to" and "different than"), but in a book of this calibre one would not expect to find a sentence like (p 163) · "A hypothyroid monkey put on a very low thyroid dosage for a period of ten days always resulted in the return of menstrual function"

The main justification for the publication of this book in face of the well-established and authoritative treatises mentioned at the beginning of this review must lie in its emphasis on farm animals and its relatively modest price, which will bring it within the reach of the private purchaser Is this publication justified ? On the showing of this first volume the reviewer thinks so, despite the criticisms mentioned above, and he is glad to recommend it

S J Folley

HÆMOGLOBIN AND SENSORY MECHANISMS

Progress in Biophysics and Biophysical Chemistry

Vol 9 Edited by Prof J A V Butler and Prof B Katz Pp vii+388 (London and New York Pergamon Press, 1959) 105*s* net

FOLLOWING the present reviewer's criticism in *Nature* of the previous volume of this series on the grounds that few of the articles matched up to the aims stated in the preface, the editors have prudently suppressed the customary preface in this volume Perhaps they need not have feared ; their aims may well be achieved, for five out of the seven articles are written in such a way as to be intelligible and interesting to non-specialists in their subjects Two of these articles have the special flavour that only comes when a scientist with a flair for exposition describes the development of a subject he has himself largely invented and contributed to These are F. J W Roughton on the kinetics of oxygen and carbon monoxide uptake by red cells and by solutions of hæmoglobin, and W A H Rushton on visual pigments and their measurement in the living human eye The book opens with an enthusiastic and highly interesting account by Q H Gibson of the rapid reactions of hæmoglobin with gases The last article which can be recommended without reservations as to style or scientific content is that in which J A B Gray describes what is known of the way sensory endings, sensitive to mechanical change, convert mechanical energy into streams of nervous impulses , he illustrates the argument mainly from his own and his collaborators' pioneer work on the Pacinian corpuscle

It would have been churlish to exclude the article by D A McDonald and M G Taylor on the hydrodynamics of the arterial circulation from the category 'intelligible and interesting', but after reading it I found I was not convinced either that their problem was an important one, or that they had advanced much towards a solution

The two remaining papers are by A Peterlin on molecular dimensions and light scattering (fifteen pages of references) and by C de Duve, J Berthet and H Beaufay on gradient centrifugation of cell particles Both of these appear to be competent and clear descriptions of the theory and practice of their highly specialized techniques, which would no doubt be of great convenience to anyone directly concerned But this volume is supposed to be about progress Is a technical description of the methods by which progress may have been achieved in the past and by which it is hoped to achieve it in the future any substitute for a critical account of progress ? It certainly makes very much duller reading than the real thing Fortunately, there is plenty of the real thing in this mainly excellent work

P A Merton

COLOUR REPRODUCTION

The Reproduction of Colour

By Dr R W G Hunt Pp 208+10 plates. (London Fountain Press, 1957) 63*s* net

THIS book expounds the principles and the crucial technical devices of the processes used in colour reproduction in photography, printing and television Many of these processes are now extremely intricate—for example, the action of the couplers of various kinds used in colour photography and the coding and transmitting of colour information on television wave-bands of limited width In the difficult task of explaining essentials in an easily read text with clear and simple diagrams and a minimum of mathematics, the author has been highly successful. A course of lectures (Royal Institution, 1953) was the starting point and much of the freshness and intimacy of a good lecture style has been preserved

A common element linking all the reproduction techniques is a dependence on the basic ideas of colorimetry and the perception of colour by the human eye, fields in which Dr Hunt's own researches are well known The exposition here is unexceptionable and, most important, it has not been allowed to expand unduly so as to upset the balance of the work Colour reproduction techniques, in their primitive form, are not capable—even theoretically—of giving exact reproduction, and much of what Dr Hunt has to say concerns colour correction methods the nine-page chapter on the general masking method in photography and the discussion of developments from Neugebauer's analysis of dot image reproduction in printing are particularly informative brief-accounts The difficulties of assessing the 'quality' of the final result in colour reproduction are well brought out, with emphasis on the inadequacy of a demand for a simple point-to-point correspondence with the original

Although the book appears to be addressed mainly to a rather lay circle, that is to say, people having to do with colour pictures in various ways but not experts, it is certain that many readers, knowledgeable in one area of the wide field covered, will find most useful this insight into related techniques In the quality of the coloured plate illustrations the publishers have not failed the author W S Stiles

Excursion Flora of the British Isles

By A. R. Clapham, T. G. Tutin and E. F. Warburg. Pp. xxxiii + 579. (Cambridge: At the University Press, 1959.) 22*s*. 6*d*. net.

THIS volume has been developed from Clapham, Tutin and Warburg's "Flora of the British Isles", published in 1952, by curtailing descriptions to little more than is needed for identification, by omitting all information not strictly relevant to identification, by omitting most of the rarer mountain species and by simplifying the accounts of such critical genera as *Rubus* and *Hieracium*. The result is very considerably to reduce the time taken in using the keys and substantially to cut down the number of wrong turns that a beginner can take. The book also is a bare three-quarters of an inch thick as against the solid two inches of the original.

In practice, it has been found that even a beginner can identify plants satisfactorily with the aid of the excellent glossary, which has been retained from the original work, and the authors must be congratulated most warmly on having produced such a practical book with up-to-date nomenclature and equally up-to-date information. In these ways their work is beyond criticism. There are, however, two gaps to be filled. The first is illustrations, and this could easily be filled by a companion volume taken from the illustrations to the larger volume, by Sybil Roles, Vol. 1 of which has already appeared. Her line drawings, in this case with only one to the page and with only those species here included, would make an invaluable supplement. Our other need is for a student's flora in Hooker's sense. The present volume could easily be modified for this purpose by the addition of something comparable to Hooker's synopsis of natural orders and natural arrangements of families.

P. Falk

Soil Chemical Analysis

By Prof. M. L. Jackson. Pp. xiv + 498. (Englewood Cliffs, N.J.: Prentice-Hall, Inc.; London: Constable and Co., Ltd., 1958.) 57*s*. 6*d*. net.

THE seventeen years that have elapsed since the publication of Piper's "Soil and Plant Analysis" have seen rapid advances in the subject of soil chemical analysis, notably by the widespread adoption of spectroscopic techniques, and a considerable need has been felt in recent years for an authoritative up-to-date treatment of methods of soil analysis. It is fortunate that Prof. Jackson has undertaken the task of meeting this need, because his diversity of interests and long experience of the complex problems of soil analysis have enabled him to write a book that is much more than a collection of recipes. Within the compass of 500 pages he deals adequately with nearly all the techniques employed in modern soil chemical analysis and also finds space for alternative methods of analysis. This coverage has been achieved by judicious selection of methods and references, concise writing, and good organization of the subject material (every paragraph is numbered to permit cross-reference).

It is easy to criticize a book of this type, and some analysts will undoubtedly question the omission or inclusion of certain procedures. There are a considerable number of typographical errors, the index is rather inadequate, and the relevance of some of the quotations under the chapter titles is obscure. However, these are minor defects, and this work deserves praise rather than criticism. The book is well illustrated, reasonably priced and generally well produced, although a more suitable type of paper could perhaps have been found for a book that seems destined to spend much of its life on laboratory benches.

This work is indispensable to anyone concerned with soil chemistry. It should be particularly welcome to teachers, because it includes suggestions for a laboratory course, pertinent questions at the end of each chapter, and admirably concise discussions of the principles of various methods.

J. M. Bremner

Curare and Curare-Like Agents

Edited by D. Bovet, F. Bovet-Nitti and G. B. Marini-Bettolo. Pp. xi + 478. (Amsterdam: Elsevier Publishing Company; London: D. Van Nostrand Company, Ltd., 1959.) 85*s*.

THIS book is the outcome of an international symposium held in Rio de Janeiro in August 1957. It is very different from previous monographs on curare and from the now familiar pattern of conferences of which the names of the participants can almost be predicted from the title: both the wide scope of the book and the large number of contributors from South American countries are welcome innovations. The home countries of the curare alkaloids have provided specialists reporting on the botany, history and ethnology of curare, on the methods used to prepare the poisoned arrows, on the survival in present days of the use of curare for hunting purposes. Other parts of the book deal with classical organic chemistry, pharmacology and clinical uses of curare and its synthetic substitutes; there are fascinating speculations on the receptor–drug interaction, which is no longer considered as a stable equilibrium but as a dynamic process in which not only the drug but also the receptor may suffer deformation and therefore changes in the course of time. The book is well produced; the autoradiographs (in P. G. Waser's article) of end-plate regions of muscle poisoned with decamethonium are particularly beautiful.

Marthe Vogt

Outline of Historical Geology

By A. K. Wells. Fourth edition revised with the assistance of J. F. Kirkaldy. Pp. xv + 398. (London: George Allen and Unwin, Ltd., 1959.) 32*s*. net.

A. K. WELLS'S "Outline of Historical Geology" was first published in 1937, and was then intended as an introduction to the stratigraphy of Great Britain for the general reader presented in such a way as to stress the cultural or philosophical value of historical geology. Later editions, written with the assistance of J. F. Kirkaldy, enlarged the scope of the work to make it more suitable for the use of students reading for a degree in geology or geography. In the present, fourth, edition, further improvements and additions have been made. A new chapter has been included on the Pre-Devonian rocks of Scotland, which incorporates the results of recent research on Highland stratigraphy and structure. New data on the Pre-Cambrian of Shropshire, on the nature of the chalk, and on the Wealden 'delta' are also included among the revisions that have been made. Selected references now appear at the end of each chapter. Despite the pressure of new facts, the authors have contrived to maintain the emphasis on principles, in accordance with the aim with which the first edition was introduced, rather than the mass of detail into which the teaching of stratigraphy can too easily degenerate.

PREPARATION OF DIAMOND

By DRS. H. P. BOVENKERK, F. P. BUNDY, H. T. HALL*, H. M. STRONG
and R. H. WENTORF, jun.
Chemistry Research Department, General Electric Research Laboratory,
Schenectady, New York

IT would be good to be able to write a paper entitled "The Preparation of Diamond", in which all the factors affecting diamonds were nicely accounted for and the formation of diamond was completely explained. But the work which has been carried out on this problem indicates that diamond can form in several different ways, and that stubborn mysteries still surround some of them. This article, therefore, is more of the nature of an interim report which describes the salient features of the knowledge obtained so far rather than a complete exposition of diamond formation.

All the observed cases of diamond preparation in our laboratory have occurred at pressures and temperatures appropriate for the thermodynamic stability of diamond. Fig. 1 shows a diamond–graphite equilibrium curve. For temperatures up to 1,200° K. the path of the curve has been estimated by Rossini and Jessup[1], Simon[2] and others from thermodynamic data. For temperatures between 1,500 and 2,700° K., the path of the curve has been determined experimentally by observations of the growth or disappearance of small diamond crystals immersed in suitable media[3].

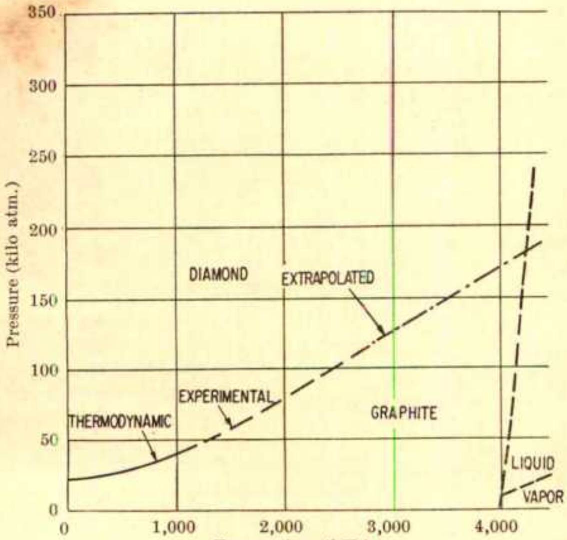

Fig. 1. Carbon phase diagram

The experiments which form the basis for most of this article were usually performed in a tapered piston apparatus capable of very high pressures which enabled us to attain diamond stability at high temperature. Figs. 2a and 2b illustrate the tapered piston 'belt' apparatus which will be discussed in detail by H. Tracy Hall in a separate paper submitted for publication. Many of the most promising systems were examined at several pressure-levels as appropriate apparatus was developed. Diamond does not always form where it is thermodynamically stable; this is what makes diamond synthesis so interesting.

The chemical systems which were studied in connexion with diamond synthesis can be conveniently grouped as follows: (1) direct transition, graphite to diamond; (2) systems involving carbon and oxygen; (3) systems involving carbon as salt-like carbides; (4) miscellaneous chemical reductions; and (5) systems involving carbon dissolved in molten metals.

(1) Direct Transition, Graphite to Diamond

The driving force for this reaction is the increase of density upon going from graphite to diamond. On the other hand, the high heat of vaporization of carbon (more than 100 k.cal./gm. mol.) implies that a high temperature will be necessary before much recrystallization of the carbon occurs. Indeed, the

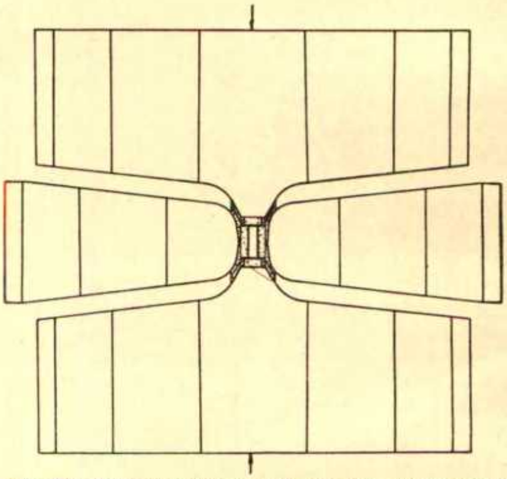

Fig. 2a. The 'belt', ultra-high-pressure, high-temperature assembly

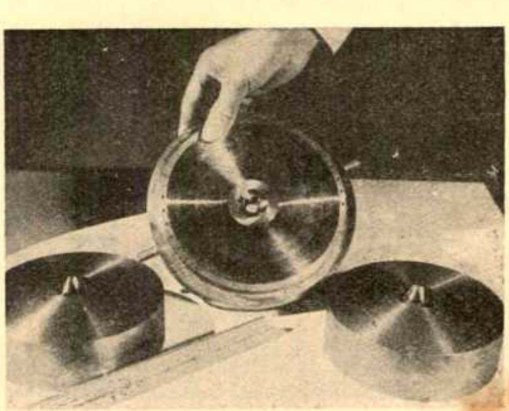

Fig. 2b. Photograph of apparatus

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* Now at Brigham Young University, Provo, Utah.

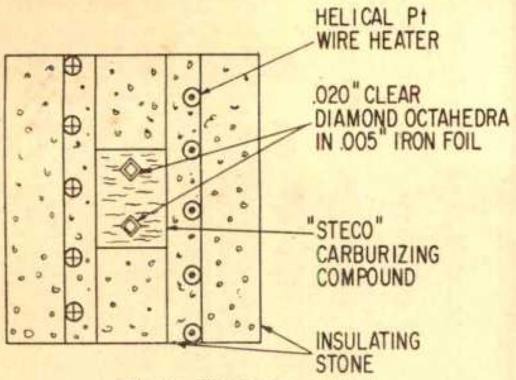
HELICAL Pt WIRE HEATER
.020" CLEAR DIAMOND OCTAHEDRA IN .005" IRON FOIL
"STECO" CARBURIZING COMPOUND
INSULATING STONE

Fig. 2c. Diamond experiment

usual range of temperatures for forming graphite industrially from petroleum coke, pitch, etc., is about 1,800–2,400° C., and some carbons graphitize only slightly at temperatures higher than these.

Some studies made in this laboratory of the graphitization of diamond at 0·1 and 20,000 atm. showed that the graphitization began at 1,500–2,000° C., depending on the particular diamond, and that, in general, higher temperatures were necessary to graphitize diamond at 20,000 atm. than at 0·1 atm. From the change in rate constant with pressure, the volume of the 'activated state' was estimated at about 160 c.c./mol., and the rate of graphitization, in atoms per second, was observed to be 10^5 times the rate of evaporation for the same temperature. This indicated that the diamonds became graphitized by groups of atoms rather than atom-by-atom. For the reverse reactions, graphite to diamond, it would be reasonable to expect a similar reaction mechanism, because the strong intra-sheet binding forces in graphite would tend to make each sheet behave as a unit (as happens in the formation of 'graphite sulphate' or potassium-graphite). Although the coherent sets of sheets of atoms ('crystallites') in graphite or various carbons contain perhaps only 10^4 or 10^5 atoms, the pressure-volume energy of such a crystallite is large compared to kT at only moderate pressures (20,000 atm.). It is known that in some carbons the crystallites are rearranged only reluctantly to form commercial graphite even at 2,700° C. and 1 atm. Thus the effect of increasing pressure is to slow down greatly any recrystallization of solid carbon, and this slowing-down more than offsets the thermodynamic driving force toward diamond gained by increasing the pressure. Experiments in which graphite was heated at high pressure served to squeeze the microscopic voids from the material, so that its density became nearly the theoretical density of graphite, but no diamond was formed, even at 120,000 atm. Perhaps diamond could crystallize from molten carbon at a sufficiently high pressure; but supposing the melting temperature of carbon to be 4,000° C. at this high pressure, one would estimate by an extrapolation that the required pressure would be in the neighbourhood of 200,000 atm. (The increasing incompressibility of graphite with pressure indicates that the required pressure might be even higher than this.) Such an experiment has evidently not yet been performed.

(2) Systems involving Carbon and Oxygen

Such systems are attractive because they are chemically versatile and tend to favour aliphatic rather than aromatic carbon–carbon bonds. The oxide mineral inclusions in natural diamonds[4–6] suggest that perhaps certain oxides could play a part in diamond formation, perhaps through a shift in the carbon monoxide – dioxide equilibrium. In spite of all these attractive features, only graphite or amorphous carbon ever appeared as products from these systems, with one possible exception. This exception was the reduction of lithium carbonate by lithium metal at high pressures. The carbonaceous residue gave a feeble Debye–Scherrer pattern for diamond and scratched glass in a way characteristic of diamond (tiny helical chips were ploughed out of the scratches). A few tiny triangular faces, 1–10μ on edge, could occasionally be seen but not identified. Further experiments did not produce more abundant or larger crystals.

Other systems which were examined included similar reductions of carbonates, oxalates or formates by metals; the decomposition of iron, molybdenum or chromium carbonyls either pure or in solution in stannic chloride or molten salts; the decomposition of sugars and ketones; the electrolysis of molten carbonates; or finally, the attempted solution and transport of elemental carbon in various molten oxides such as borates, silicates, phosphates, 'blue ground', etc.

(3) Systems involving Carbon as Salt-like Carbides

These systems are attractive because they are comparatively rich in carbon, contain carbon atoms as free ions which could easily be built into a diamond lattice after a simple reduction, and are chemically active at low temperatures. However, only the high-pressure decomposition of lithium carbide by the outward diffusion of the lithium ever yielded any potentially diamondiferous product. The material from this decomposition gave a weak Debye–Scherrer diamond pattern, corresponding to a diamond content of about 1 per cent, and also scratched glass to leave the characteristic helical chips.

Other more disappointing reactions included the decomposition $2MgC_2 \rightarrow Mg_2C_3 + C$, the cyanamide reaction $CaC_2 + N_2 \rightarrow CaCN_2 + C$, the electrolysis of calcium or lithium carbides, and the substitution reaction $SiC + Ge \rightarrow SiGe + C$.

(4) Miscellaneous Chemical Reactions

Carbon disulphide is thermodynamically unstable at ordinary pressures and temperatures. At pressures about 45,000 atm. and 400° C. it was found to change into the black solid described by Bridgman[7]. In combination with various metals used as catalysts or reducing agents, carbon disulphide changed into amorphous carbon at higher temperatures and pressures. Similar reductions of chloroform, carbon tetrachloride or cyanides formed amorphous carbon.

Hannay's method was tried, in which lithium, light hydrocarbons and nitrogen-containing substances were heated together at high pressure. Again only amorphous carbons appeared. The simple thermal decompositions of various hydrocarbons yielded similar products, and no diamond.

(5) Systems involving Carbon dissolved in Molten Metals

These systems turned out to be the most fruitful and also, unexpectedly, the most complex.

In our early work, when available pressures were still less than about 50,000 atm., some experiments

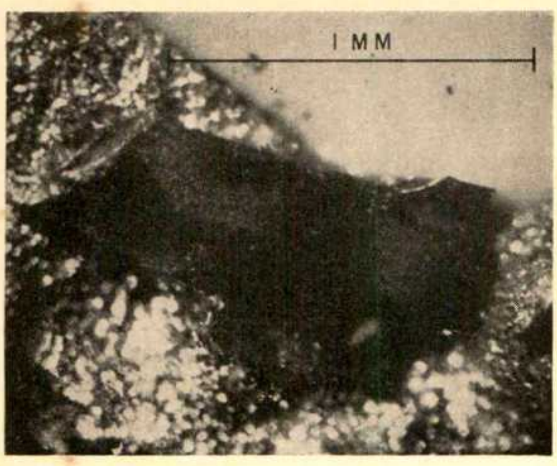

Fig. 3. Diamond in metallic matrix

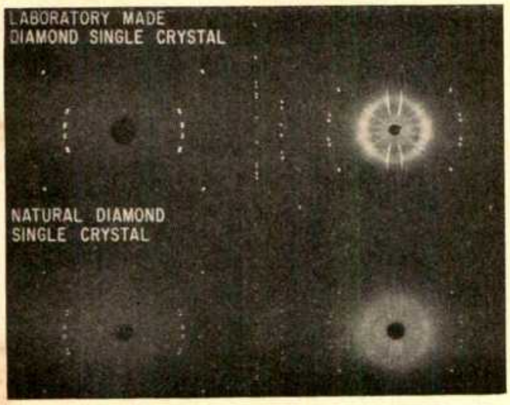

Fig. 4. Debye–Scherrer patterns

were performed with molten aluminium, silver, and even iron. Of course, iron dissolved carbon in appreciable amounts; but the carbon which was precipitated from it was in the form of graphite. No matter how careful the change or how great the fluctuation of temperature, when the pressure was less than 50,000 atm., only graphite resulted. In view of this, it is difficult to see how Moissan's claim to have formed diamond from molten iron–carbon mixtures inside his quenched iron could be sustained, since he could have reached at most only 10,000 atm.[8,9].

A number of experiments were performed using a metallic catalyst and carbonaceous material. One of the first experiments carried out involved heating some seed diamond crystals, iron and a carbonaceous steel-carburizing compound for 16 hr. at about 53,000 atm. and about 1,300° C. (Fig. 2*c*). Out of this there appeared two new diamond fragments with developed crystal faces, each of which was larger than any of the seed crystals. The identification was made by hardness tests and an X-ray diffraction pattern (Figs. 3 and 4). Attempted repetitions of this experiment did not produce diamond. However, it now appears that the iron–carbon system is quite complex at high pressures and temperatures. Several solid phases can form, among them FeC, Fe_3C, graphite and diamond; but which one happens to form depends upon slight variations in temperature, temperature change or chemical composition. Even at 100,000 atm., certain temperature programmes will not permit any diamond to form from iron–carbon mixtures.

Shortly afterwards, a mixture of iron-rich iron sulphide together with carbon and tantalum, as shown in Fig. 5, was heated at about 1,600° C. at about 95,000 atm. The heating time was short, less than 10 min. On the tantalum end disks there formed tantalum carbide, and on top of this lay a black crusty layer of small diamond crystals (Fig. 6). They were identified by their hardness, combustibility and X-ray diffraction pattern. The experiment was successfully repeated many times.

Soon other substances were found to be effective as catalysts for the conversion of carbon into diamond at pressures ranging from 55,000 to 100,000 atm., and temperatures ranging from 1,200 to 2,400° C. They were chromium, manganese, cobalt, nickel, palladium, platinum, etc., or compounds which would react to give the free metals under these conditions, for example, nickel oxide, ferric chloride, etc.

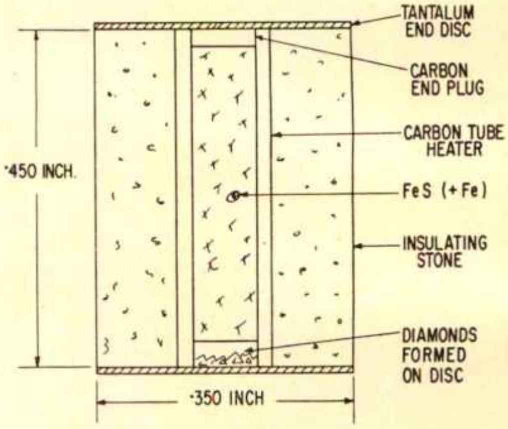

Fig. 5. Diamond experiment

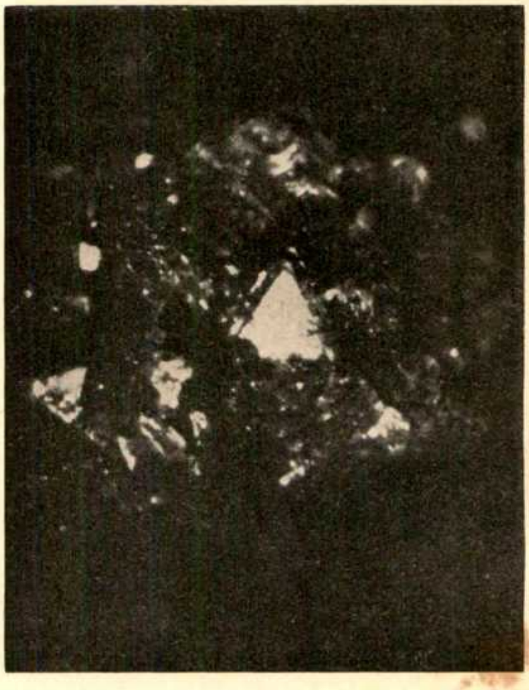

Fig. 6. Cluster of synthesized diamonds

After many experiments it became possible to list some of the conditions peculiar to the formation of diamond.

(1) The pressure and temperature of the system should be those for which diamond is thermodynamically stable.

(2) The temperature must be high enough to ensure that the catalyst metal, saturated with carbon, is molten. Thus the intersection of the melting line of the metal – carbon eutectic with the graphite – diamond equilibrium line sets a lower limit on the temperature and pressure which can be used to form diamond with a particular catalyst. In Fig. 7 the diamond-growing region is shown as a shaded area on the pressure – temperature diagram.

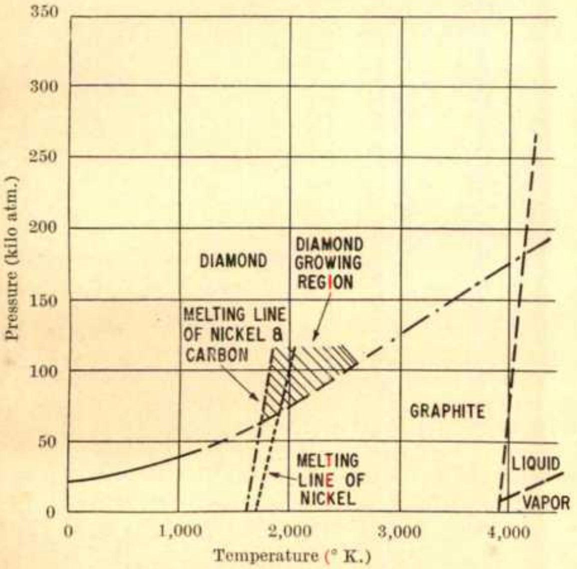

Fig. 7. Diamond-growing region

(3) The catalyst metal can be chromium, manganese, iron, cobalt, nickel, ruthenium, rhodium, palladium, osmium, iridium or platinum. Tantalum is particularly effective for inducing the growth of small diamond crystals, although in some circumstances it may not be as catalytically active as the other metallic catalysts.

(4) New diamond can form whether diamond seed crystals are present or not.

(5) As the synthesis pressure and temperature are moved further into the diamond-stable region away from the graphite–diamond equilibrium line, the rate of nucleation and growth of the diamonds increases and their average crystal-size decreases.

(6) The diamond can grow at very high rates, at least 0·1 mm. per min.

(7) The actual transformation from carbon to diamond occurs across a very thin film, about 0·1 mm. thick, which separates the carbon from the diamond. Thus the transformation is almost 'direct', but the catalyst is essential (Fig. 8). So far it has been found to be very difficult to grow diamond buried in molten catalyst even 1 mm. away from the source of carbon.

(8) Although the main driving force for the formation of diamond is the thermodynamic potential difference between graphite and diamond, temperature gradients can accelerate diamond growth due to the dependence upon temperature of the solubility of carbon in the catalyst.

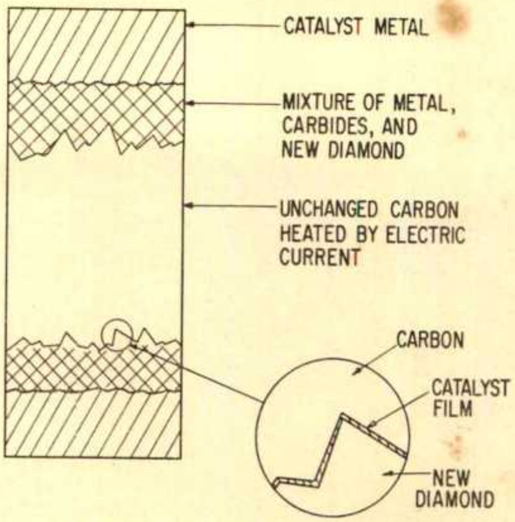
CATALYST METAL
MIXTURE OF METAL, CARBIDES, AND NEW DIAMOND
UNCHANGED CARBON HEATED BY ELECTRIC CURRENT
CARBON
CATALYST FILM
NEW DIAMOND

Fig. 8. Diamond growth from graphitic carbon

(9) The kind of carbon used as a starting material has an effect on the kind and number of the diamonds formed. Good results have been obtained in making diamonds employing ordinary commercial graphite as the starting material. Other carbonaceous material may be employed as the source of carbon, such as carbon black or a sugar charcoal; but graphite is preferred.

(10) Sometimes graphite forms from a carbon-rich melt, particularly when the melt freezes, even though the pressure and temperature are appropriate for diamond stability. Diamond may or may not form at the same time. Apparently the formation of diamond is not a simple process.

(11) The diamonds easily include or grow around foreign particles present in the mixture, particularly at high rates of growth. Often some of the catalyst metal will be thus trapped in a diamond crystal.

(12) The diamond crystal habit varies according to the temperature of formation. Cubes predominate

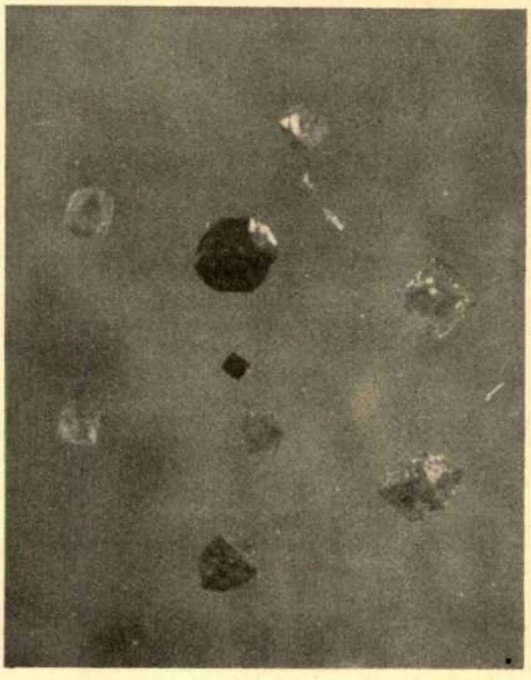

Fig. 9

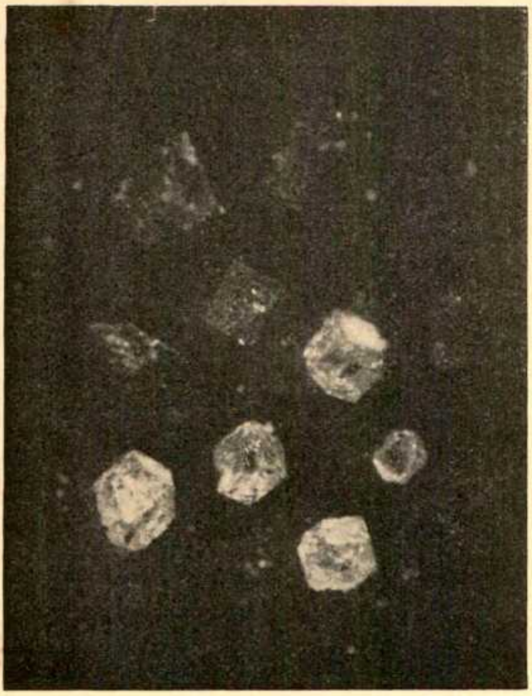

Fig. 10

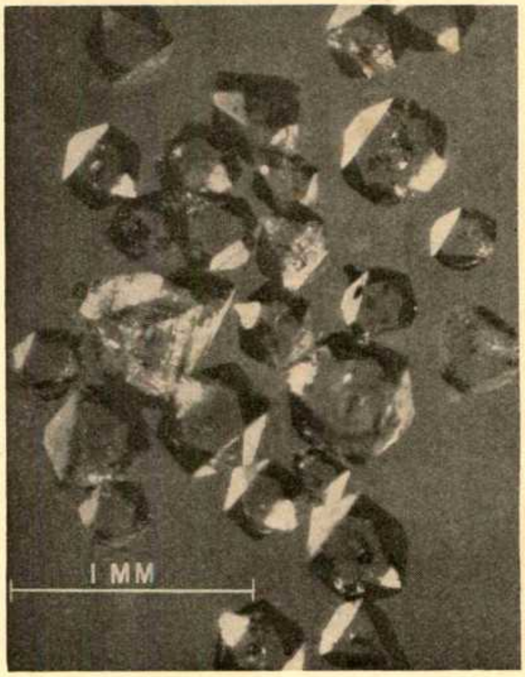

Fig. 11

at the lowest temperatures, mixed cubes, cubo-octahedra and dodecahedra at intermediate temperatures, and octahedra at the highest temperatures. No tetrahedra have been found. At high growth-rates, octahedra are frequently twinned through an octahedral face as a mirror plane. Growth terraces or steps are common on the diamond crystals, but no growth spirals have been found so far. The colour varies from black at low temperatures through dark green, light green and yellow, to white at the highest temperatures. In many cases, the colour does not depend on the particular catalyst used but on the operating temperature relative to the melting point of the catalyst–carbon mixture. Green and yellow colours seem to be associated with imperfections in the diamond crystal lattice rather than with the presence of a specific impurity. Many of the physical characteristics of natural diamonds have been duplicated in the laboratory[10].

Some photomicrographs of various synthetic diamond crystals are shown in Figs. 9–11.

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FASCICULUS LIMPIDUS NOV. GEN., NOV. SPEC., A REPRESENTATIVE OF A NEW GROUP OF BACTERIA

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A PECULIAR organism, the nature of which puzzled me much at first, was observed in putrefaction cultures inoculated with a small quantity of soil from a dried-up pool not far from Cape Town, South Africa. It contained fragments of twigs and rock along with powdery earth. This soil sample had been very kindly sent to me by Dr. M. A. Pocock, Rhodes University College, Grahamstown, with the idea that it contained colonial Volvocaceae. This was the case: *Volvulina*, a mixothrophic member of the Volvocaceae, together with species of *Chlorogonium*, *Coccomonas* (or *Dimorphococcus*), an undescribed species of *Lobomonas*, an interesting species of the Polytomeae, and others turned up under suitable conditions.

Successful cultures were prepared in the following way: a quarter of a dry pea was put on the bottom of a test-tube, covered with clay soil and water and heated in a steam chamber for 1 hr. on two consecutive days. The following morning, or later, inoculation was done with a small amount of the original soil.

The culture was kept in the light. Other mixtures, such as grains of barley, bits of cheese, a little starch, different kinds of soil instead of clay soil, did not produce the same interesting type of biological community, but only a much more scanty growth without Volvocaceae and the new organism here described.

The original soil, even in much greater quantity, with water or a dilute mineral nutritive solution and trace elements, was still less productive. This is noteworthy, because it is of general application. It shows that the soil sample no longer contained enough of the substances which had originally produced the mixed population, the resting stages of which regained vitality in the tubes prepared as described. It also indicates that heating of the clay soil is necessary for these organisms to find suitable conditions for growth.

In all other instances the various organisms appearing in such putrefaction cultures could be maintained indefinitely by inoculating them into identical tubes without the original soil, in series. Not so the new organism, which also failed to multiply in a considerable number of media with various organic substances usually suitable for the nutrition of colourless flagellates, bacteria, etc. After repeated washing of the new organism before inoculation, such tubes remained clear and sterile.

In the original culture tubes the peculiar organism in question was observed in considerable quantity near the surface of the soil-mud. The experiment was successfully repeated several times with the same and similar soil samples from the Cape Flats, but only when light was admitted did the new organism appear. It consisted of translucent, almost spindle-shaped structures tapering at both ends when inspected with low magnification inside the culture tubes. Later, the new organism swarmed in the higher regions, too, but the water never really teemed with them, and the other organisms mentioned above were always present.

For closer investigation, specimens of the organism were picked up with the capillary pipette and inspected in hanging drops or in mounted preparations. What was mistaken for colourless, finely striated flagellates at low magnification was at high power seen to be composed of long filaments, some of them bent and twisted to form colonial bundles. These were broadly spindle-shaped, often somewhat flattened, with both poles tapering but not strictly pointed (Figs. 2–5). The individual filaments arranged more or less parallel to one another, though converging, did not all terminate at the same point. Under pressure of the cover-slip they tended to spread, the filaments separating (Fig. 11). Indian ink penetrated between the units of the colony. There is, therefore, no gelatinous matter surrounding the whole or glueing the filaments together. They are united in bundles (*fasciculus*) and have a translucent, limpid appearance. The organism will therefore be called *Fasciculus limpidus*.

In suitable conditions the colonies moved along their axes, rotating as flagellates generally do. They did not glide along solid surfaces but swam freely through the water, though more slowly than infusoria or even the majority of flagellates usually do.

The motile colonies may aggregate chemotactically. This became apparent when a quantity of culture fluid in a watch glass was inspected for a longer period. Various motile organisms, such as *Spirilla*, small infusoria and *Coccomonas*-cells, assembled around debris particles, were followed by the colonies of our organism, most of which aggregated after some time at certain points. In such open watch glasses, contained in a Petri dish, *Fasciculus*, poured from a test-tube culture, together with other members of the community, kept only for a few hours and could not be identified the following morning, while *Volvulinopsis* and the others kept moving for a whole week. A probable inference is that *Fasciculus* is micro-aerophil, an idea strengthened by our experience and observations with cultures.

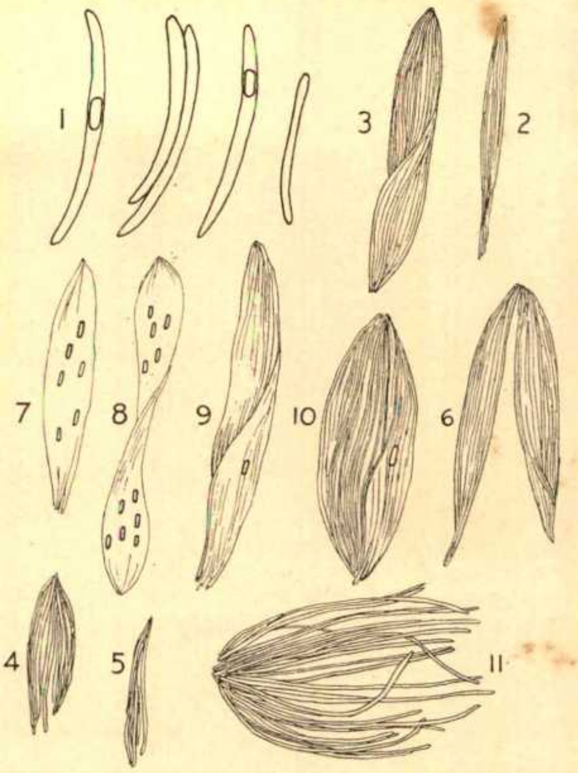

Fig. 1. Individual components of colony mechanically isolated, two of them with spores. 2, Small, narrow colony. 3, Large, twisted colony. 4 and 5, Small, frayed colonies. 6, Rare instance of longitudinally split colony. 7–10, Colonies with spores: 7, colony of the most frequent types—during spore formation, the outlines of the filamentous components have become invisible to a great extent; 8, colony with narrow waist and spore formation; 9 and 10, more or less twisted colonies, each with one spore. 11. Normal colony with filaments separated by pressure on cover-slip. (Fig. 1, × 1,000; others, × 500)

The shape and appearance of the colonies varied (Figs. 2, 4, 5). Apart from the large closely-knit spindles with only slightly frayed ends, there were smaller and narrower ones, and occasionally, though rarely, slightly bent, slender rods which, judging by their optical appearance, belonged to the same organism. Sometimes two narrow spindles cohering at one pole were seen (Fig. 6). Larger, presumably older, colonies had a constriction in the middle, and the filaments were twisted (Figs. 3, 8). The waist is believed to indicate an imminent partition of the colony.

Cells shorter than the total length of the colonies, and others which divided like bacteria, could often be observed. There is little doubt that the units divide after reaching a certain length, and that the daughter cells glide along one another to increase the width of the colonial bundles. I did not, however, find any signs of individual filaments breaking loose from the colonies and starting new ones.

The main mode of reproduction is by spore formation. In older cultures, colonies were found which were more limpid than young ones. Only their outlines were readily observable, while the inner parts of the spindle were optically almost empty except for small cylindrical bodies which by their high refractability, particularly in dark-ground illumination, revealed their nature as bacterial spores (Figs. 7, 8). This was confirmed by their capacity for retaining the fuchsin stain on treatment with acid alcohol.

Later on, transition stages in spore formation were also found in colonies in which the filamentous cell-units were still readily visible. Not all of these formed spores. The spores were usually close to the middle. Their shapes varied from almost oval to, more commonly, cylindrical. Their width was about 1·5μ, their length 5–7μ.

These spores are no doubt the reproductive units responsible for the development of *Fasciculus* from completely dry soil. Their germination could, unfortunately, not be observed because of the failure to cultivate the organism and to separate it from other organisms. It is very peculiar that the individual cell margins vanish almost completely during spore formation, although the whole colony continues to swim about, and its outlines remain clearly visible (Figs. 7, 8).

The structure or nature of the filaments composing the large spindles is also different from that of most bacteria. As already mentioned, optically the organism is fainter than other organisms. In dark-ground illumination it becomes more distinct, and the outlines of the filaments show more clearly than, for example, the outer membranes of Myxobacteria.

These filaments are believed to be cells. They are 2μ across and about 50–100μ in length. They stain with fuchsin and methylene blue, but, in accordance with their low refractability, not strongly. They do not keep the Gram stain, contrary to most bacterial spore-formers. Only the membranes of the spores were stained; they were also more deeply coloured when treated with the Ziehl-Neelsen technique.

The mode of locomotion, rotating and swimming freely through the water, recalled that of flagellates or large bacteria. I did not succeed in demonstrating flagella with the help of Loeffler's technique, of Deflandre's nigrosin method, or dark-ground illumination. Quick drying on fat-free cover-slips or fixing with osmium tetroxide vapour or iodine or Schaudinn's mercury chloride fixation did not make any difference. But I believe this failure was somehow due to inadequate technique, and do not doubt that flagella do exist, since the impression of the swimming movement scarcely allows of any other interpretation.

If this were so, we would have another example of an 'organized' bacterial colony as earlier described for *Vannielia aggregata*[1]. This belongs to the Athiorhodaceae, a family where colony formation had not been known to exist. There, also, many cells are aggregated to constitute a composite unit driven through the water and rotating by co-operation of the flagella; but here the similarity ends. While in *Fasciculus* the units of the colony are long, tube-like structures, those of *Vannielia* are rod-shaped cells radiating from the centre of the colony. Another motile bacterial colony is that of *Chlorochromatium aggregatum*, where again the arrangement of the individual components is quite different. Only one relatively large, central rod possesses a flagellum responsible for the movement of the colony, while the yellowish green small outer cells only adhere to the actively swimming central rod.

It is not possible to include *Fasciculus* in one of the taxonomic groups of the Bacteria. Very long, tubiform cells are known in *Lineola*[2], but this genus does not form colonies, and the production of spores and the appearance of the cells are different. In *Lineola* droplets and other contents are visible under the microscope, and the staining with various dyes is quite normal for a bacterium. *Fasciculus* is much less stainable and the inner part of the cell is almost empty optically. Moreover, the ecological conditions in which the new organism thrives seem to be peculiar. A better insight into its nature could only be obtained by cultivation. I will gladly supply portions of dry soil to bacteriologists who are interested in this creature.

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BIOLOGICAL PROBLEMS ARISING FROM THE CONTROL OF PESTS AND DISEASES

THE Institute of Biology has developed a technique for cutting through the hedges which grow up between fields of knowledge as biology undergoes speciation into ever new branches. One of the methods of doing this used by the Institute is to arrange symposia for which the subjects and speakers are chosen with considerable care. Thus, before even a word was spoken in the Royal Geographical Society's well-filled lecture hall on October 1, a look around indicated a successful meeting, for there were many well-known specialists in different fields who seldom previously have found themselves sitting in one room. The subject of this two-day symposium, namely, "Biological Problems arising from the Control of Pests and Diseases", is one of wide and topical interest. The speakers, including those who contributed to several stimulating discussions, were economic entomologists and botanists, medical men and veterinarians, psychologists and humanitarians, in addition to academic biologists.

The symposium was arranged in four sessions, each under a different chairman. This arrangement divided the subject rather broadly into problems associated with arable agriculture, animal husbandry, human disease and health, but the matter presented tended to transcend any grouping. It became apparent that there are many connecting threads between, for example, the drug resistance developed by bacteria and the stimulation to growth of animals consequent on small additions of antibiotics to their diet, that the consequences of malaria control react quickly on the ecological problems of crop and animal pests through changes in human needs, and that too rigid a control of mental deficiency might have a retarding influence on science and art. Several facets of the discussion pointed to the human being as the greatest pest of all One speaker was bold enough to suggest that every pest and disease worthy of the name was, in fact, a human artefact, and given time he might convert almost every surviving wild organism into a pest Although some would scarcely go so far, there were several expressions on the value of maintaining at least some areas of the world in a natural or semi-natural state Thus, in the problem of controlling agricultural pests, reference was made to Elton's plea for ecological diversity if only to provide reservoirs of the predators and parasites of pests.

The stage was set by Mr F C Bawden, chairman of the first session, who directed attention to the unexpected and sometimes undesirable results which follow action against any particular pest or disease of importance in agriculture The control of one may let in another He was unable, however, to quote any case where the secondary trouble had resulted in greater economic loss than the primary one, and therefore concluded that on the whole there was always a net gain This theme was taken up by Mr A H Strickland, of the Ministry of Agriculture and Fisheries Plant Pathology Laboratory at Harpenden He provided a valuable assessment of recent work with insecticides, but neglected the classical work of biological control because it was well covered in a recent survey by Prof G C Varley in a paper before the Royal Society of Arts He instanced cases where eradication of species had been attempted, such as the Colorado beetle from Europe and the Mediterranean fruit fly, which has twice been introduced into and eradicated from the United States, and he pointed out that in Britain no less than a fifth of the acreage of root and some vegetable crops is treated annually with insecticides as a routine measure To those—including many farmers—who deplore the very widescale use of insecticides and herbicides as an excuse for sloppy husbandry, Mr Strickland had some encouraging words about recent studies of the manipulative possibilities such as physical control of the soil by rotovation, and the adjustment of spacing in sowing and planting which can render crops unattractive to pests or stimulate the crop to grow away

Dr. T J Martin, of the Research Station, Long Ashton, dealt with the direct risks to man arising from the fact that fifteen out of the forty-two or so insecticides and fungicides in common usage are in the highly toxic category Study of the risks to spray operators led to the Agriculture (Poisonous Substances) Regulations of 1956, and, in spite of some accidents, it seems that the risks to the consumers of crops which have been subjected to a variety of toxic sprays are under control, at least in Great Britain Discussion revealed that, with the exception of arsenic, for which there is a legal tolerance, the use of any spray on the land in Britain is entirely at the discretion of the manufacturer and the farmer Neither Dr Martin nor any other speaker was in a position to deal with the influence of toxic materials on wild plants and animals or on game, although these largely unknown but important influences were doubtless in mind It is abundantly clear that there is to-day a heavy responsibility falling on entomologists and botanists to obtain and interpret information on the selectivity and tolerance-levels of these chemicals, in order to give advice to manufacturers and users on formulations, dosages and methods of application in such a way that indiscriminate slaughter can itself be brought under control

Mr F G H Lupton, of the Plant Breeding Institute at Cambridge, set a different note by describing some striking successes in controlling diseases through genetical resistance or tolerance, but he mentioned that all too often the plant breeder is called in only when other methods have failed Among other examples he described the ding-dong race which was started in 1912 by Sir Roland Biffen and is still in full cry between the genes of newly evolving races of the rust fungus and resistant genes of wheat sorted out by plant breeders The series Marquis – Ceres – Thatcher – Pilot – Selkirk have so far kept alive the economy of the Great Plains, but the race is still neck-and-neck

The second session introduced several problems from overseas Thus, Mr M Crawford, of the Commonwealth Bureau of Animal Health at Weybridge, emphasized that eradication of a killing disease of livestock, such as rinderpest, could lead to harmful effects from over-population, over-grazing and malnutrition if achieved among peoples who regard stock as a social or religious asset without economic controls Such experience was referred to also by Mr W H Potts, formerly of the Colonial Service, with reference to the control of tsetse flies and trypanosomiasis He was not, however, prepared to support the tendency in recent years to hail the tsetse fly as the preserver of the African soil from destruction by man This theme, like the earlier one on controlling agricultural pests, led to discussion on the advantages or disadvantages of ecological diversity as a background for the economic use of land There is, for example, evidence that in the African semi-arid bush the broad spectrum of wild indigenous fauna, fully adapted to living off the indigenous vegetation at all levels, could, under proper systems of management and annual cropping, produce human food little if any less than is produced by the narrow spectrum of exotic domestic stock At least there is a case for spending money to explore such possibilities in selected areas, rather than to spend all that is available on the blind eradication of wild-life and tsetse flies

The control of human diseases in tropical areas was the subject of two contributions, by Prof T Davey, of the School of Tropical Medicine at Liverpool, and Sir Gordon Covell The latter mentioned that during the World Health Organization campaign there were two hundred teams working in India, each of which looked after one million people. Despite such campaigns, the Organization's figures show that the annual loss from malaria is still a vast one The improvement of physique and of work undertaken by persons in malarial areas is marked, following control There is normally some resistance to malaria, but this resistance is only local, so that an influx of persons from another district may result in severe outbreaks Although Sir Gordon did not say so, this, of course, was known in England during past centuries, when it was noted that a wife from outside taken into such malarial areas as the Fens or Hundred of Hoo was liable to die within a short time, whereas the locals were in balance with their disease

Prof Davey dealt more with the sociological problems expected as a result of the control of such diseases as malaria, and pointed out that nowadays in India the excess of births over deaths is some 15,000 a day In discussing birth control as the biological remedy, he mentioned that certain classes are more amenable to birth-control methods than others, and that in a low-level subsistence type of society every additional member of the family gives another worker, and so a better chance for survival. Where social conditions are better, each additional mouth is a liability rather than an asset. Thus the lower the subsistence-level the greater the birth-rate tends to be.

Dr. E. Slater, of the National Hospital for Nervous Diseases, raised some interesting points about the genetics of mental disease, and pointed out that the discovery of new methods of treatment enabled certain diseases which are transmitted genetically as dominants to increase their proportion in the population. This was simply done by overcoming the biological disadvantages which these dominant genes will contain, provided no treatment is given. Among the interesting points he made were that the manic-depressive type of patient is met with ten times as frequently among scientists as among the rest of the population. This may be a question of either cause or effect. Schizophrenics are found particularly among artists, and in these patients fertility is only 70 per cent that of normal. There is a possibility that this disease may be associated with some genetic advantage. The question whether certain types of mental defective should be sterilized is difficult because it is possible that workers in, for example, the artistic and scientific fields, may show improved output over the normal if they have some minor degree of mental disease.

The problems which arise from drug-resistance in bacteria were treated in a sparkling contribution by Dr. Mary Barber, of the Postgraduate Medical School, London. She pointed out that not all bacteria have taken the massive attack by antibiotics in clinical medicine lying down; in the case of *Staphylococcus diogenes*, drug-resistant strains are now the major bacterial scourge in hospitals all over the world. Resistant strains of bacteria may be drug-tolerant or drug-destroying, and in certain cases may even become drug-dependent. Evidence points to the resistance being genetic rather than adaptive, and that penicillin, for example, has caused a prodigious evolution in the population structure of *Staphylococcus* by simple selection. Those strains carrying resistant genes which formerly were present in a tiny proportion have now increased to 60 or 70 per cent of the population in most hospitals. The same principle applies in the case of insect resistance to the new synthetic insecticides, as explained by Dr. J. R. Busvine, of the London School of Hygiene and Tropical Medicine. In more than a hundred harmful insects resistant strains have occurred, and in some cases the inheritance of the resistant trait has been shown to be of a normal Mendelian type. Whether the trait is 'physiological', which is immune to the poison, or 'behaviouristic', which manages to avoid it, its emergence seems to constitute greatly accelerated evolution on essentially Darwinian lines. Dr. R. Brande, from the National Institute for Research in Dairying at Shinfield, spoke on the recent experiments which show that very small amounts of antibiotics added to the diet of domestic animals increase growth-rate up to 10 per cent and the efficiency of food conversion by from 3 to 5 per cent. He explained that economic advantage of this phenomenon is being taken now on quite a large scale in the United States, although the biological reasons for it are as yet in the realm of conjecture.

The last contribution to the symposium was by Dr. G. C. L. Bertram, from St. John's College, Cambridge, who spoke of 'ethical' or deliberate selection in mankind as having supplanted natural selection. He sketched the sequence of events which led to a doubling of the human population in the past eighty years or so, and the probability that it will double again during the next forty years—European dominance, followed by reduction of strife, the development of hygiene, and the control of biological competitors. Human compassion has led to death control, and now is the time for a great extension of birth control as a further expression of the freedom of choice by the individual. Having accepted Sir James Gray's concluding thought expressed in his presidential address at the York meeting of the British Association that man now has the intelligence and the knowledge to control his own destiny, the question has still to be answered what that destiny is. In a cynical moment, Dr. Bertram compared modern man with a drunkard riding a runaway horse, whereas Dr. A. S. Parkes, who guided this final session from the chair, expressed the hope that our freedom of choice would never become so wide that we would ourselves have to decide whether or not to be born.

E. B. WORTHINGTON

DARWIN'S ILLNESS

By PROF. S. ADLER, O.B.E., F.R.S.

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DARWIN'S illness, which practically amounted to forty years of invalidism, has given rise to considerable speculation. The doctors who treated him could find no physical explanation for his distressing symptoms and apparently concluded that he was a hypochondriac.

Darwin, whose sufferings were very real, complained in a letter to Hooker "many of my friends I believe think me a hypochondriac". Commenting on this, the late Sir Arthur Keith[1], in his book "Darwin Revealed", remarks emphatically: "Darwin *was* a hypochondriac, a very real one . . .".

Hubble[2] states that "it is apparent that his illness bears the unmistakeable marks of an emotional disorder" and adds, "his psychoneurosis may be regarded as an adaptation to his environment which nourished and protected in the highest degree his uncommon genius". This author[3] justifies his diagnosis on the basis of Darwin's family history. He rightly points out that Darwin's wife was an exceptionally devoted nurse and his son showed a tendency to hypochondria. It may, on the other hand, be argued that the above qualities were acquired and not inherent; chronic invalidism in the head of a family, whatever its cause, has psychological consequences and may well induce in the mother a strong tendency to nurse and protect, and in the younger members of the family an exaggerated fear of disease

Good[4] invokes psycho-analysis and considers the whole of Darwin's symptoms as a reaction to his father's autocratic personality He goes so far as to say, "Darwin's punishment for the unconscious patricide was a heavy one—almost forty years of severe and crippling neurotic suffering which left him at his best fit for three hours' daily work"

Keith accepts the unconscious as responsible for all Darwin's symptoms "In Darwin's case the voluntary part of his brain seems to have too easy and too free an access to his involuntary part Therein I believe lies the source of all his ills " Nevertheless, in referring to one episode of 1873 he writes, "I infer this to be an attack of true angina of the heart"

A purely psychological aetiology for Darwin's illness cannot be accepted as conclusive until all other factors have been eliminated Gaylord Simpson[5] has recently suggested that Darwin suffered from brucellosis There is no direct evidence to refute or prove this theory

It is obvious that all attempts to explain Darwin's symptoms must be based on a detailed analysis of the events recorded in the voyage of H M S *Beagle,* because there is nothing of any medical significance prior to the voyage which could throw light on his subsequent illness As Lady Barlow[6] rightly remarks, "Charles Darwin's forty years of invalid existence moreover were an unexpected sequel to his youthful vigour, for his strength and endurance were well above the average, as Captain Fitzroy has recorded in his account of the various incidents during the *Beagle* voyage"

Darwin was a dedicated geologist and throughout his whole life maintained the keenest interest in this subject Nevertheless, at the age of thirty-three, he was compelled to abandon field work in a favourite subject because he found by experience that the physical effort it entailed exhausted him Is it reasonable to ascribe this sacrifice to a belated reaction to a domineering father ?

There is one very important point in Darwin's case-history which writers on the subject have apparently overlooked

In "The Journal of the Voyage of H M S *Beagle*", Chapter 15, Darwin (March 25, 1835) writes "We slept in the village of Luxan which is a small place surrounded by gardens and forms the most southern cultivated district in the province of Mendoza , it is five leagues south of the capital At night I experienced an attack (for it deserves no less name) of the Benchuca a species of Reduvius, the great black bug of the Pampas It is most disgusting to feel soft wingless insects about one inch long crawling over one's body Before sucking they are quite thin but afterwards they become round and bloated with blood, and in this state they are easily crushed " Darwin observed 'Benchucas' for at least four months and he fed one specimen on a ship's officer "This one feed for which the Benchuca was indebted to one of the officers kept it fat during four whole months , but after the first fortnight it was quite ready to have another meal "

The "great black bug of the Pampas" which attacked Darwin in Luxan can be no other than *Triatoma infestans,* which has become adapted to human habitations and feeds on man and domestic animals throughout extensive regions in South America It is the most important vector of *Trypanosoma cruzi,* the causative agent of Chagas's disease, in the Argentine, Chile and parts of Brazil The province of Mendoza has a relatively high incidence of Chagas's disease, and according to South American colleagues with whom I discussed this problem at the recent congress on Chagas's disease held in Rio de Janeiro during July 5–12 [see p 1114 of this issue of *Nature*], as many as 60 per cent of the population in parts of Mendoza give a positive complement-fixation test for *T cruzi* and as many as 70 per cent of specimens of *Triatoma infestans* are infected with the trypanosome Darwin was therefore definitely exposed to infection on at least one occasion It is highly probable that he was also exposed on other occasions, but he particularly noted the incident in Luxan because of the intensity of the attack of Benchucas , parts of Chile through which he passed show a 10 per cent positive complement-fixation test in the population together with a considerable infestation with infected *Triatoma infestans* We must also bear in mind that Chagas's disease has a very wide distribution in South America from Chile to Mexico (recently a few cases have been recorded in Texas) and the province of Mendoza is an area of relatively high infestation

The incident in Luxan cannot, however, explain Darwin's previous seven weeks severe illness during September and October 1834 which confined him to bed in Valparaiso and commenced during the last week of a six weeks journey Unfortunately, no clinical details of this episode are available Keith writes, "As to the nature of this illness I do not know of any exact information but typhoid fever is a very probable diagnosis" There is not the slightest suggestion of an emotional cause for this incident

The complications and sequelæ of Chagas's disease have been studied in detail by some of the ablest South American pathologists and clinicians, particularly in Brazil, the Argentine, Chile and Uruguay, and considerable literature on this subject is now available Particular attention has been paid to the clinical and pathological aspects of the myocarditis which appears in some victims of the disease Darwin's exhaustion after physical effort can well be explained on the basis of an infection with *T cruzi*

At the above-mentioned congress a number of Brazilian pathologists and clinicians maintained that apart from, and in some cases in the absence of, cardiac complications, Chagas's disease may be associated with clinical signs related to the alimentary tract, particularly the œsophagus, colon and stomach, as a result of damage to Auerbach's plexus They based their conclusion on the high incidence of positive complement-fixation tests in patients with symptoms related to these organs There was no unanimity on this point because although many such cases have been found in Brazil, few or none have as yet been recorded from the Argentine

It is obviously impossible to *prove* that Darwin was a victim of Chagas's disease but two points cannot be overlooked · (1) his symptoms can be fitted into the framework of Chagas's disease at least as well as into any psychogenic theory for their origin , (2) it is possible to pin-point with certainty a definite incident on March 25, 1834, during which he was exposed to optimal conditions for infection with *T cruzi*

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OBITUARIES

Mr J T Davey and Mr H. J Morris

In the air disaster at Bordeaux on September 24, the International African Migratory Locust Organization, which exists to prevent the escape of swarms of the Migratory locust from the recognized outbreak area in the flood plains of the Niger south-west of Timbuktu, suffered a very severe blow The fifty-three people killed included no less than eight associated with that Organization Mr J T Davey, aged thirty-six, director of research , Mr H J Morris, aged thirty-six, an experienced scientist newly appointed as an assistant to Mr Davey, and his wife , Madame Duhart, wife of Monsieur A J Duhart, director of survey and control, and one of their children , and Monsieur J J Rey, one of the locust control officers, and his wife and child

James Thomas Davey graduated from the University of Bristol and then took a diploma in agriculture at Cambridge and spent a year at the Imperial College of Tropical Agriculture in Trinidad He first went to Africa in 1947 as an entomologist in the Department of Agriculture in Nigeria, where he investigated the habits and ecology of certain species of biting flies (tabanids and tsetse flies) At the same time, he became interested in locusts, and in 1948 he embarked on a detailed ecological study of the African Migratory locust, partly in association with H B Johnston Particular attention was paid in this study to the neighbourhood of Lake Chad, which was under suspicion as a possible outbreak area and the important conclusion was reached that while the Migratory locust does occasionally swarm there, the Chad area is not comparable as a source of swarms with the recognized outbreak area in what was then the French Sudan

With this valuable experience behind him, he accepted in 1951 an invitation from the International African Migratory Locust Organization to visit the outbreak area on the Niger in order to extend investigations already begun by others of the ecology and seasonal movements of the locust there His secondment to that Organization by the Government of Nigeria for this purpose was extended in 1952 for two years An outcome of this mission was a decision by the Council of the Organization to establish a permanent Research Service Davey became director of it, and he continued in that capacity until the time of his death Through his own ability and personal qualities, including a very thorough practical knowledge of French acquired mainly by usage, the Research Service and its scientific work became integrated into the Organization in a highly successful manner, which could not have been achieved without the respect, affection and support which he won from all his colleagues

His scientific work consisted mainly of studies of the seasonal movements of the locust population in and around the Niger plains in relation to the seasonal rainfall, river-level and flooding of the plains by overflow from the river By means of an impressive programme of field-work which involved the marking of more than a million locusts individually with paints, during a period of four years, and releasing them in particular localities in and outside the plains in the hope of recapturing some of them elsewhere, he succeeded in demonstrating a regular seasonal shift of population (already suspected by G Remaudière, who conducted an ecological study of the locust in the flood plains during 1949–50) between the plains and the surrounding arid country His work further indicated that certain parts of the plains are far more important than others as breeding grounds of the locust A much better understanding of the outbreak area as such has resulted from these investigations, and this has led to important improvements and economies in the supervision and preventive control of the locust

Davey travelled widely in Africa in the course of his duties In 1953 he visited the outbreak areas of the Red locust in Northern Rhodesia and Tanganyika and toured parts of the vast area of eastern Africa over which the Desert Locust Survey, which has its headquarters in Nairobi, operates Recently, he went to the Sudan Republic to see and discuss with the authorities there the circumstances in which a local increase in the population of the Migratory locust had occurred His interests were wide and he was a good companion on journeys in remote places His zest for life and his vigour and resourcefulness enabled him to take in his stride the many difficulties, some of them severe, which arise in 'bush travel' in Africa The wild life of Africa appealed to him greatly He knew the mammals of his areas well and was a keen shot, but he never shot animals solely for the sake of shooting In connexion with his work, he made extensive collections of grasshoppers and plants, and these have added considerably to knowledge of the acridid fauna and the flora of the Niger flood plains and the surrounding country

Fortunately, he made a point of writing accounts of his work at frequent intervals, and very little of the work that he had completed will be lost His most important publications are two long papers on the ecology of the Migratory locust in what he called the Central Niger Delta , these form part of a planned series of three, and it is understood that the third part was virtually complete in typescript when he died It is fitting that this valuable series of papers is being published in *Locusta*, the journal of the international organization which he served so well

The death of 'Jimmy' Davey, while still young, removes a man who was confidently expected to play an important part in the field of locust research and control in the future His wife survives him, with three young children

Hilary Jolliffe Morris graduated from St John's College, Oxford, in 1948 A few years later he joined the Research Division of the Ministry of Agriculture of the Sudan, where he undertook pioneer studies of techniques of control of the Desert locust This work, which covered a period of five years, contributed significantly to the development of aircraft-spraying and of low-volume ground-spraying against locusts, and in the course of it he became familiar with methods for the field-assessment of spray deposits and of the results of spraying operations

In 1957 he joined the Colonial Pesticides Research Unit at Porton Down, near Salisbury, England, where he was occupied for two years in laboratory work on the toxicity of new insecticides to mosquitoes He was essentially a field-man, however, with a strong liking for Africa and a desire to resume locust research, and when a suitable opening occurred in the Research Service of the International African Migratory Locust Organization he applied for the post and was selected

This new appointment was for an investigation of the applicability of modern methods of locust control, particularly spraying from aircraft, in the conditions of the outbreak area of the Migratory locust on the Niger Morris was very well fitted by his accumulated experience and personal qualities for this important task, and he set out with high hopes and keen interest on the journey which was to have taken him to the sort of work that he liked best and considered worth while because of its benefit to Africa

Mr and Mrs Morris had been married only six months when they died

T H C TAYLOR

NEWS and VIEWS

Scientific Adviser to the Ministry of Defence.
Sir Frederick Brundrett, K.C.B, K B.E.

IT has been announced that Sir Frederick Brundrett will be retiring at the end of the year from his post of scientific adviser to the Ministry of Defence, and chairman of the Defence Research Policy Committee, shortly after his sixty-fifth birthday Sir Frederick has had a life-time's association with the scientific aspects of defence, initially within the Admiralty, and for the past ten years of his career dealing with defence science in all its aspects A member of the R N V R in the First World War, he joined the scientific staff of the Admiralty in 1919 and remained at H M Signal School, Portsmouth, until 1937, when he moved to headquarters His remarkable qualities as a scientific administrator and his perception of scientific ability were given full scope during the Second World War, when he made a major contribution to the selection and allotment of scientists to the several departments needing them Since the War his talents for organization have been given full rein at the Admiralty and elsewhere, but his greatest contribution has undoubtedly been in the clarification and stabilization of defence research and development policy as a whole over the past few years His contributions to the rationalization of the research and development programme so as to harmonize the needs of the Services with the national resources have been markedly successful, and a great debt is owed to him for his work in this field What he has accomplished is due to three qualities which he has in abundance a real understanding of Service needs and Service modes of thought, a basic understanding of scientific practices and requirements, and a capacity for hard, thorough and clear-headed work equalled by few and probably excelled by none A distinguished player of games when younger, and an extremely successful scientific agriculturist to-day, it is to be hoped that his advice and his services to the Scientific Civil Service will not wholly end with his departure from the Ministry of Defence

Sir Solly Zuckerman, C.B, F.R S.

SIR SOLLY ZUCKERMAN, who is to succeed Sir Frederick Brundrett as scientific adviser to the Ministry of Defence, is no stranger to either defence or to Whitehall Sir Solly was born in South Africa in 1904, he came to Britain in 1925 and rapidly became known as a distinguished research anatomist He at present holds the Sands Cox chair of anatomy in the University of Birmingham, and he is especially well known for his work on the primates During the Second World War his wide scientific talents were drawn on freely by many branches of the Services, but he was perhaps most closely associated with the Royal Air Force, and he made important contributions to the operational analysis of the effects of bombardment, particularly from the air In the past decade he has combined his work at the University of Birmingham with many other activities, including his duties as honorary secretary of the Zoological Society during a rather stormy period, and with the deputy chairmanship of the Advisory Council on Scientific Policy, towards the work of which and some of its sub-committees, notably the Committee on Scientific Man-Power, he has made a major contribution He succeeds Sir Frederick Brundrett at a difficult time when it may well be that a closer integration between civil and defence science is necessary, and when indeed some re-thinking may be necessary on the balance between the two For this task Sir Solly, by his previous experience, his exceptional ability and warm personality, is excellently qualified

Meteorological Branch of the Canadian Department of Transport: Dr. Andrew Thomson, O.B E

DR ANDREW THOMSON, who on September 25 retired from the post of director of the Meteorological Branch of the Canadian Department of Transport, a position he has held for the past thirteen years, is well known in the world of meteorology A graduate of the University of Toronto, his first studies were in geophysics, and during 1920–21 he was put in charge of investigations into atmospheric electricity during the round-the-world cruise of the Carnegie Institution research ship In 1923 he became director of the Apia Observatory, Samoa and in 1929 aerologist of the Dominion of New Zealand He returned to Canada in 1931 as head of the research division of the Meteorological Service, and assumed charge of the whole service in 1946. Dr Thomson has done much in the international field, especially as a member of the Executive Committee of the World Meteorological Organization and as president of the Regional Association for North and Central America of the World Meteorological Organization A great traveller, who has not only done much to build up an efficient national service but also to promote international co-operation in meteorology, he was made O B E in 1948, and awarded the gold medal of the Professional Institute of the Public Service of Canada in 1952 and the honorary degree of D Sc by McGill University in 1958 He carries into his retirement the best wishes and affection of all who know him

Mr. Patrick D. McTaggart-Cowan, M.B.E.

THE appointment of Mr P D McTaggart-Cowan to succeed Dr Andrew Thomson as director of the

Canadian Meteorological Service comes as no surprise to the world of professional meteorology, for he has been Dr Thomson's right-hand man for many years Mr McTaggart-Cowan, who is forty-seven, was born in Scotland but has spent most of his life in Canada After securing first-class honours in mathematics and physics at the University of British Columbia, he won a Rhodes scholarship to Corpus Christi College, Oxford, where he graduated with honours in natural science He joined the Canadian Meteorological Service in 1936 and quickly became known internationally, especially in relation to trans-Atlantic aviation, then in its infancy During the Second World War he was largely responsible for the development of forecasting at the Canadian end of the ferry flights to and from Britain When hostilities ceased he took an active part in the formation of the body which has now become the International Civil Aviation Organization Among professional meteorologists his name stands high, not only as a forecaster, but also as an energetic and skilful administrator, with a gift of clear thinking and direct speech The future of the Canadian Meteorological Service could not be in better hands

Chemical Engineering at Leeds:

Prof. G. G Haselden

Dr G G Haselden, whose appointment to the new chair of chemical engineering at the University of Leeds has been announced, was educated at Sir Walter St John's School, Battersea, and the Imperial College of Science and Technology, London He graduated in chemical engineering with first-class honours in 1944 and afterwards undertook research under the late Sir Alfred Egerton on problems connected with the liquefaction of methane on the results of this work he was awarded his Ph D In 1949 he was appointed lecturer and later senior lecturer in low-temperature technology in the Department of Chemical Engineering of the Imperial College In addition to his teaching duties, Dr Haselden has during the past ten years built up an active school in low-temperature research His main fields of interest have been in the liquefaction of natural gas, the development of new or more efficient gas-separating processes and refrigeration cycles, and the measurement and correlation of the thermodynamic properties of mixtures In 1958 he was awarded the Lightfoot Medal of the Institute of Refrigeration for his work on mixed refrigerants Dr Haselden was one of the founder members of the Low Temperature Group of the Physical Society, and he is a member of the Education and Papers Committees of the Institution of Chemical Engineers and a member of the Research Committee of the Institute of Refrigeration

Illuminating Engineering Society Award:

Dr J. W. T. Walsh

To mark the occasion of its golden jubilee, the Illuminating Engineering Society has instituted an award to be known as the Illuminating Engineering Society Gold Medal, which will be bestowed at intervals of not less than two years for outstanding contributions to the advancement of lighting Recipients of the medal may be of any nationality and need not be members of the Society At the meeting of the Illuminating Engineering Society held in London on October 13, the first award of the gold medal was made to Dr J W T Walsh, who is without doubt the most outstanding and highly esteemed person in the world of lighting to-day. From Merton College, Oxford, Dr Walsh went to the Department of Photometry of the National Physical Laboratory until he retired in 1951, having been there for thirty-eight years His first outstanding contribution was the making of a large-scale photometric survey of factory lighting for the Home Office Departmental Committee in 1913 During subsequent years, he supervised much important work relating to the principles of good lighting and to the design and performance of lighting equipment, and he published a number of papers on all aspects of photometry and illuminating engineering Dr Walsh served for many years as chairman of the British National Illumination Committee and has participated actively in the meetings and work of international bodies concerned with lighting He has served as honorary secretary and vice-president of the International Commission on Illumination and was president of that body from 1955 until June 1959 He has been a member of the Illuminating Engineering Society since 1923, he is the only member who has served two terms as president of the Society (1929 and 1947) He was chairman of the committee responsible for the current codes of practice for street lighting Dr Walsh has indeed been a prodigious worker in the cause of better lighting and this together with his high principles and strict regard for scientific accuracy has endeared him to lighting people all over the world. There is no doubt that his contributions to the advancement of lighting have been truly outstanding

Royal Australian Chemical Institute:

Mr C. E. C Nicholls

Mr C E C Nicholls has been elected president of the Royal Australian Chemical Institute He was born and educated in England, and gained his degree in the University of London with honours in chemistry After spending about two years with the British-American Tobacco Co, Ltd, he joined the Distillers Co, Ltd, in October 1929, very shortly after the latter company had entered the chemical field He spent some years at the Company's main factory in Hull, and brought into operation the first synthetic acetic acid plant in England Early in 1942 he was sent to Australia, where he played a major part in establishing the war-time synthetic acetone production Early in 1945 Mr Nicholls returned to England, where he resumed duties with the Distillers Co, Ltd He made a short visit to Australia in 1946, and again in 1947 when the Colonial Sugar Refinery and the Distillers Co, Ltd, obtained a larger interest in Robert Corbett Pty, Ltd He is at present manager of Colonial Sugar Refinery Chemicals Pty, Ltd, and a director of Robert Corbett Pty, Ltd He was elected a Fellow of the Royal Australian Chemical Institute in 1947, holding office as president of the New South Wales Branch for two years and during the last year of this term he was also vice-president of the Institute

Atomic Energy Authority's Thermonuclear Programme

The United Kingdom Atomic Energy Authority is seeking the necessary approvals to acquire and develop a site of some 175 acres within the perimeter of the Royal Naval Airfield at Culham, Oxfordshire, for development as a new research establishment The new establishment would be for research into controlled thermonuclear reactions and plasma physics and the study of nuclear fusion as a possible source of industrial power Most of the thermonuclear research now carried on at Harwell and Aldermaston will be moved to the new establishment One of the immediate tasks at the new site, if approved, would be the construction of I C S E (Intermediate Current Stability Experiments), a large machine which (as announced at the Authority's annual press conference in July) will incorporate the results of experience with *Zeta* and of other studies in this field, both at home and abroad It is planned that the total numbers employed at the proposed new establishment will rise to 1,000 and that this figure will be reached within four or five years

Divorce Statistics in Britain

THE principal changes that have been introduced in the Civil Tables of the Registrar General's Statistical Review for 1957 which has been published recently relate to divorce statistics (The Registrar General's Statistical Review of England and Wales for the year 1957 Part 2 Tables, Civil Pp xii+200 London H M Stationery Office, 1959 11*s* 6*d* net) Figures for divorces and annulments are now given by calendar year of marriage and age of spouses at marriage, so that the risk of divorce of different marriage cohorts may now be computed, and there are some other welcome new details on divorce An appendix shows details of marriages by manner of solemnization in different countries It is intended to publish this table at five-yearly intervals, and these data give a useful indication of the distribution of different religious groups in the country It is of some interest that the proportion of civil marriages shows a fall, compared with 1952, for the first time since such marriages were instituted in 1836 In addition to these new figures, more detailed fertility tabulations giving better exposed-to-risk are also included in this volume

Sex Research

THE Division of Medical Sciences of the National Academy of Sciences—National Research Council is accepting applications for grants-in-aid of research for consideration by the Committee for Research in Problems of Sex The funds for support of this programme are provided by the Rockefeller Foundation and the Ford Foundation The Committee is concerned primarily with encouraging research on the mechanisms underlying sexual behaviour, with special emphasis on the higher mammals and man Proposals involving endocrinological, neurological, psychological, anthropological, phylogenetic and genetic studies directed toward this objective are therefore invited Requests that deal with the physiology of reproduction or with related biological and biochemical fields should be addressed to the Committee only if they give promise of shedding light upon behavioural mechanisms Preliminary inquiries should be addressed to Room 411, Division of Medical Sciences, National Academy of Sciences—National Research Council, 2101 Constitution Avenue, N W , Washington 25, D C Completed applications for the fiscal year 1960–61 should be postmarked on or before January 15, 1960

Variation in Lizards of the *Leiocephalus cubensis* Complex in Cuba and the Isla de Pinos

Leiocephalus cubensis Gray has been regarded as one of the four species of this genus in Cuba and the Isla de Pinos, and has been known to occur throughout both islands in suitable habitats Albert Schwartz has collected 388 specimens and studied additional material from various museums , this has resulted in the partition of *L cubensis* into two species, each with four subspecies *L cubensis* is now known from Cuba and the Isla de Pinos, the Doce Leguas keys, and the Archipiélago de los Canarreos, where the new species, *L stictigaster*, occurs in western Cuba and the Isla de Pinos The status of Oriente lizards of this complex remains uncertain Schwartz believes that *stictigaster* and *cubensis* arose from a common stock through isolation on western and central island masses during the Oligocene and Lower Miocene Periods With the re-establishment of the island to approximately its present outline between the Lower and Middle Miocene, these two species extended their ranges gradually from the regions of differentiation From modern distribution it appears that the gap between western *stictigaster* and eastern *cubensis* may not yet be closed *L cubensis* also has spread to the east into Oriente as well as the west into Matanzas and Habana (*Bulletin of the Florida State Museum, Biological Sciences*, 4, No 4 , 1959).

Transparent Sintered Alumina—'Lucalox'

SINTERED or vitrified ceramic materials of polyphase composition are normally opaque owing to scattering of light by the different refractive indices of the component phases Single-phase sintered ceramics are usually both opaque and porous owing to the difficulty of sintering refractory substances sufficiently well to produce optical contact between the grains The General Electric Co of America announces the experimental production of a material, under the trade name 'Lucalox', which is formed by pressing from alumina powder of small grain size and fired under conditions, presumably *in vacuo* and at a very high temperature, which permit almost complete sintering to occur The product is non-porous and sufficiently transparent for print to be read through a thickness of the material in contact with the paper Objects viewed at greater distances are, however, blurred as though through frosted glass It retains the refractory qualities of alumina, and is said to be stable up to about 1,900° C Possible fields of use include envelopes for high-intensity light or radiant heat sources, as a superior alternative to fused silica Light-transmission in the visible spectrum, through an unstated thickness, is said to be 90 per cent Since the material is in effect a polycrystalline sapphire, it may offer an alternative to synthetic mono-crystalline sapphire for instrument bearings Its electrical properties are not stated, but would presumably resemble those of sapphire , a permittivity of about 9 5, loss angle between 10^{-4} and 10^{-3} at room temperature, and appreciable conductivity appearing around 300–500° C , depending upon purity The problem of production as a commercially satisfactory operation is said to be still under investigation

International Conference on Non-Destructive Testing

THE third International Conference on Non-Destructive Testing will be held in Tokyo during March 15–21 The Conference is intended to provide an opportunity for the exchange of information on the latest development in scientific research and industrial application in non-destructive testing in different parts of the world and for the discussion of improvements in testing techniques It will also deal with problems of international co-operation The main part of the Conference will consist of four principal sessions (two in Tokyo and two in Osaka) and a number of technical sessions Further information can be obtained from the secretary of the British National Committee for Non-destructive Testing, 1 Birdcage Walk, London, S W 1

University of Texas Grant for Genetic Research

THE University of Texas has received a grant of 1,482,480 dollars, to boost basic research in genetics and cell biology over a five-year period, from the National Institutes of Health, the Public Health Service research centre at Bethesda, Md The grant will support research in the areas of population genetics, genetic effects of radiation and cosmic rays, chromosome studies of cancer and normal cell strains, cytogenetics, and the physiological and biochemical aspects of genetics Seven principal investigators, their associates and assistants working in the Genetics Foundation of the Department of Zoology, will conduct the research Principal investigators will be Prof W S Stone and Drs C P Oliver, R P Wagner, J J Biesele, M R Wheeler, B H Judd and H S Forrest, all members of the University's Genetics and Cell Biology Group

Royal Meteorological Society Officers for 1959–60

THE following have been elected officers of the Royal Meteorological Society for 1959–60 *President*, Dr J M Stagg, *Vice-Presidents*, Dr H L Penman, Prof P A Sheppard, Dr G D Robinson and Dr R M Goody, *Vice-President for Canada*, Dr W L Godson, *Vice-President for Scotland*, R Cranna, *Treasurer*, B C V Oddie, *Secretaries*, P J Meade, Dr R S Scorer, J S Sawyer (editor) and Dr A G Forsdyke (librarian)

University News

Cambridge

MR G R CROWE, who joined the Cavendish Laboratory more than fifty years ago and was well known as personal assistant to Lord Rutherford, has had conferred on him the honorary degree of M A

Leeds

THE following grants are announced from the Department of Scientific and Industrial Research, £1,835 towards the cost of cosmic-ray research in the Department of Physics, £12,000 over three years for an investigation into high-pressure chemistry and geochemistry in the Department of Chemistry, £3,000 over three years for research by Dr P Gray in physical chemistry, and £1,050 for research in high alumina cements in the Houldsworth School of Applied Science, 6,000 dollars a year for two years from W R Grace and Co, of the United States, for a research fellowship in physical chemistry, £1,422 from the Marine Biological Association for research on the electron microscopy of marine flagellates, £3,000 for 1959–60 from the National Coal Board, North-Eastern Division, and £1,000 from Richard Sutcliffe, Ltd, for research in mining, and from the Agricultural Research Council for two research projects, £1,893 in the Department of Agriculture and £2,807 for research into the interpretation of fibre types in sheep in the Department of Anatomy

Lectureships are announced as follows Mr D I Davies (Department of Organic Chemistry), Mr A R J Gaskin (Department of Geology) as from October 1, Mr A N Hillas (Department of Physics), Mr M D Longfield (Department of Mechanical Engineering) as from January 1, 1960, Mr A R Mathieson (in the chemistry of high polymers in the Department of Textile Industries) from January 1, 1960

London

THE title of professor of virology in the University of London has been conferred on Dr Forrest Fulton in respect of his post at the London School of Hygiene and Tropical Medicine The title of professor of epidemiology in the University of London has been conferred on Dr D D Reid in respect of his post at the London School of Hygiene and Tropical Medicine The title of reader in pharmaceutics in the University of London has been conferred on Dr D Train in respect of his post at the School of Pharmacy

Announcements

MR ERNEST TURNER JONES, deputy controller (Overseas Affairs) Ministry of Aviation, has been elected deputy chairman of the Nato Advisory Group for Aeronautical Research and Development Mr Jones is the first deputy chairman to be appointed by the Group, of which Dr Theodore von Karman has been chairman since its inception in 1952

DR NORMAN G GAYLORD, vice-president of research and development of the Polymer Division of the Western Petrochemical Corporation and a senior lecturer at the Polytechnic Institute of Brooklyn, has been appointed editor of *Resins, Rubbers, Plastics*, the loose-leaf abstract service issued monthly by Interscience Publishers, Inc, New York It is hoped to accelerate the publication of abstracts of foreign as well as American articles, and the organic aspects of polymer chemistry will be given a greater emphasis than in previous volumes The subscription price of *Resins, Rubbers, Plastics* is 90 dollars

THE third Australian Nuclear Research Foundation Summer School for Science Teachers is to be held during January 11–20, 1960, at the University of Sydney Each science teacher attending the School is to be paid an amount to help defray expenses he may incur in so doing The total costs of the 1960 School will be in excess of £13,000 The following donations have been made towards these expenses Philips Electrical Industries Pty, Ltd, £3,500, Ampol Petroleum, Ltd, £2,500, W D and H O Wills (Australia), Ltd, £3,500 Further information can be obtained from Dr S T Butler, Department of Physics, University of Sydney, Sydney, New South Wales

ERRATA We regret that one of the names appended to the communication entitled "Light-induced Production of Carotenoid Pigments by *Cephalosporia*" in *Nature* of August 29, p 741, was incorrect, the authors are "R C Codner and B C Platt"

In the communication entitled "Bence Jones Proteinuria associated with a Transplantable Mouse Plasma-Cell Neoplasm" in *Nature* of August 22, p 654, column 1, par 2, lines 4 and 8, for "α-globulin" read "γ-globulin", par 6, line 3, for "β-globulin" read "γ-globulin" Footnotes 4 and 8 should read "Fahey, J L " and "Osserman, R M ", respectively

MELLON INSTITUTE

REPORT FOR 1958–59

THE annual report of the chairman, M B Ridgway, to the Board of Trustees of the Mellon Institute for the year ended February 28, 1959, records an increase in the Institute's independent research staff from 22 to 56, while a further 254 scientists and their assistants were engaged on the 47 industrially sponsored applied science fellowships and projects at the close of the year (Scientific Research in Mellon Institute 1958–1959 Pp x+38 Pittsburgh Mellon Institute, 1959) A plan was developed for industrial affiliation with the fundamental research sector of the Institute's programme whereby co-operation can contribute to the support of fundamental research in a designated area

During the year the independent research programme embraced studies of some of the properties of a group of esterases, with special reference to the cholinesterase of human blood plasma A rapid ultraviolet spectrophotometric method was developed for the assay of hydrolysis of certain substrates and evidence obtained that promotion of enzyme activity depends partly upon a competition between the activator and the substrate for a negatively charged site on the enzyme Studies of fibrogenesis in collagen solution were undertaken to explore the spatial arrangement of the protein amino groups which are regarded as responsible for the characteristic bands observed in collagen fibrils with the electron microscope Investigations continued on the mechanism of enzymatic hydroxylation and on the chemical structures of two metabolites of *p*-aminobenzoic acid

In inorganic chemistry the relatively little-known chemistry of osmium was studied, and besides the discovery of univalent osmium evidence for a zero-valent osmium complex was obtained For studies of the magnetic properties of transition metal compounds a magnetic susceptibility balance was set up, utilizing a 'Varian' 4-in electromagnet and a vacuum microbalance A further programme is concerned with the formation, reactions and structures of inorganic species containing cation–oxygen, cation–hydroxyl and cation–water linkages, while studies in the chemistry and physics of natural and synthetic macromolecular substances continued to develop The contribution of the chain configuration to the internal energy of a polymer has been determined from the dependence on temperature of the stress of the cross-linked polymer This occurs when stretched in the amorphous state, and for polyethylene and poly*iso*butylene this energy effect can be correlated with independently estimated energy differences between the principal bond conformations Stress–temperature measurements on fibres prepared from muscle by extraction and chemical cross-linking can be satisfactorily interpreted as due to reversible melting and crystallization processes Studies on branched-chain polymers have sought to synthesize molecules of precisely known structure and to correlate their physical properties with the chain architecture. These included a theoretical analysis of the distribution of molecular weight resulting from the formation of branched molecules, while investigation of the statistical thermodynamics of dilute polymer solutions continued A theoretical study of the diffraction pattern of a crystal containing a single dislocation indicates that it is doubtful whether or not double-crystal spectrometer measurements can be used to obtain dislocation densities from first principles

In the fields of organic chemistry the structure of the alkaloid skytanthine has been firmly established by a combination of classical degradation and instrumental methods The existence in cyclic sulphite esters of a stereoisomerism arising from the non-coplanarity of the sulphite group has been demonstrated by a nuclear magnetic resonance method The kinetics of the dehydrohalogenation and rearrangement of 1 1-diarylhalogenoethylenes have been studied and also the possible extension of the reaction to purely aliphatic and alicyclic systems Installation of a 'Varian' dual-purpose nuclear magnetic resonance spectrometer operating at 60 Mc /s has greatly assisted the solution of many organic analytical problems From July 1, 1958, the half-time responsibility for service research in the Institute's former Department of Research in Chemical Physics was transferred to the newly established Research Services High-resolution infrared absorption measurements have been conducted by the matrix isolation technique at temperatures as low as 4 2° K on the photolysis products of ammonia, 1 2-diazine and azomethane, survey spectra of about 150 inorganic salts containing polyatomic ions have been obtained in the cæsium bromide region (700–300 cm^{-1}) using a special long wavelength infra-red spectrometer and a Raman apparatus with red excitation Crystal diffraction studies of simple organo-silicon compounds are being pursued, the structure of dicobalt octacarbonyl is under investigation for information about the bonding of the cobalt atoms, while new relations between thermodynamics and continuum mechanics have been revealed in an investigation of the axiomatization of thermodynamics Current studies in radiation research include the radiation decomposition of hydrocarbons, using gas chromatography for analysis, the kinetics of photochemically produced free radicals and the radiation-induced cross-linking of polymers in solution During the year five fellows were appointed in organic chemistry

Fellowship investigations under 'metals programme' include the thermodynamics of systems of importance to the steelmaker, a long-range research and development programme to evaluate ferrous alloys for high strength, particularly at high temperatures, and the physical metallurgy of semi-conductor devices Continued attention was given by the Artists' Materials Fellowship to the fading of pigments and loss of solubility of varnishes in light The chemical hygiene fellowship is giving increased attention to the safety of food additives Under the water pollution abatement fellowship a paper chromatographic technique has been developed for determining fatty acids in water, and a continuous counter-current extractor is being used to recover soluble organic matter from river water Under the organic synthesis fellowship, heterocyclic derivatives, such as imidazolines, hexahydropyrimidines and perhydrotriazones, which give excellent crease resistance to cotton, have been prepared; the study of emulsion paints comprising homo- and co-polymer systems has indicated a correlation between water-resistance, hardness and flexibility of latex films, and polymer composition; and the investigation of polyethers from polyols and propylene oxide has assisted the rapid growth of the polyurethane foam industry. Both the coal chemicals fellowship and the petroleum fellowship cover a wide field and, under the power rectifier fellowship, laboratory development of the first new power rectifier was completed and the growth of highly perfect single crystals of silicon and germanium has been studied. New organosilicon compounds, monomers and polymers have been prepared under the silicones fellowship, including some hybrid organotin organosiloxane compounds.

LABOUR TURNOVER

LABOUR turnover has been a subject of inquiry and discussion since interest was first focused on the problem during the First World War. It is commonly regarded as a source of serious economic waste. The level of turnover in a firm is often regarded as an index of morale among the employees.

Research workers have attempted to analyse the causes of labour turnover by relating it to different groups of factors. The most important of the external factors are the level of employment and the availability of alternative work. The internal factors are the composition of the labour force itself, that is to say, whether men or women are employed, whether they are skilled or unskilled, the length of time workers have been employed, their age and the location of their homes. Wage rates, hours and conditions of work and the personal relationships existing within a firm may also have important effects on labour turnover.

The findings of research do not appear to have helped managements very much in their efforts to reduce labour turnover. The British Institute of Management survey of 1949 and 1950, covering approximately two hundred companies, showed annual labour turnover rates varying from 13 per cent to 59 per cent for men and from 24 per cent to 75 per cent for women per annum. These are industry rates. Individual companies fluctuated below and above this range. Labour turnover was calculated on the basis of

$$\frac{\text{Number of leavers in period under review}}{\text{Average number of persons employed during same period}} \times 100$$

Commonly agreed facts about labour turnover are that in any given period it is heavier among short-service employees than among those of longer service and that much of it does not represent true mobility but, from the social point of view, useless changes from one job to another.

What has not been established is to what extent labour turnover matters to the individual company and to society and the extent to which labour turnover can be measured in financial terms or whether its effects are largely intangible and in any event non-financial.

Excessive labour turnover is assumed to cause waste and inefficiency. Few studies have attempted to find out what exactly is the extent of this waste. One of the drawbacks is the difficulty of measurement. The effects of labour turnover are widespread and varied and attempts to assess them in financial terms can easily become either over-simplified or over-imaginative and remote from verifiable facts.

An appraisal of the importance of labour turnover to industry cannot be complete unless there is some estimate of its financial effects. Certain effects as, for example, the impact on the morale of the working group of a continually changing labour force, cannot be assessed in financial terms. The more tangible costs are also important.

What has been needed is a series of published case-studies of the experience and of the financial cost of labour in individual concerns. The British Institute of Management has now published a series of sixteen such studies*. The studies have been of the cost of labour turnover among direct production workers. No studies have been undertaken among clerical or selling staff.

The data provided by these case-studies and by supplementary information obtained from a large number of firms show that:

(1) In five out of sixteen studies, labour turnover was adding 10*s* or more per week to the wage cost of each individual employed.

(2) The main factors which appear to affect labour turnover cost are the impact of learners on production, the extent to which saleable production is lost through labour turnover and the methods used to make up production losses.

(3) The amount spent on training, induction and interviewing is a matter of company policy and will naturally affect the level of its labour turnover cost. Money spent in this way, however, has a constructive result and is not waste, as is the cost arising from other categories.

(4) Labour turnover has certain long-term effects which are not measurable in financial terms. Most important of these are the effect of high labour turnover on the morale of the work force, the wear and tear on supervisory staff and the loss of customers' goodwill by failure to fulfil orders and to meet delivery dates. To combat these effects by reducing labour turnover, it seems worth spending money on training, induction and interviewing.

(5) Labour turnover appears to be most costly in those firms where there is a high proportion of semi-skilled jobs peculiar to the company itself. This is because the training period is often long and it is rare to find new employees with experience of similar work. The recognized skilled occupations and the relatively unskilled ones, for example, labouring and cleaning, do not involve companies in high training costs.

(6) The results of the inquiry as a whole suggest that keeping labour turnover low may be a relatively expensive business, almost as expensive as allowing it to increase with consequent increased production costs and sales losses. The decision about how much to spend on reducing labour turnover must be based not only on the figures of tangible waste but also on management's estimate of the seriousness of the non-financial aspects.

T. H. HAWKINS

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* "Cost of Labour Turnover", 17*s* 6*d*.

STRONTIUM-90 IN HUMAN DIET

RESPONSIBILITY for estimating the contamination of food by radioactive fall-out has now been transferred to the Agricultural Research Council. The report, "Strontium-90 in Human Diet in the United Kingdom, 1958" (London: H.M. Stationery Office, 1959. 4*s*.), thus continues the series formerly issued by the Atomic Energy Authority.

The general level of radioactivity in food in the United Kingdom for 1958 was small, comparable with that found in the United States, and well below any danger-level. Most of the radioactivity in milk and dairy products, bread and flour, and in leafy and root vegetables, was brought about by the deposition of radioactive debris on the leaves of herbage and crop plants during periods of rain, followed by foliar absorption of (in particular) strontium-90. Only the material deposited during the two months before herbage was eaten by cows or before crops were harvested appeared afterwards in appreciable amounts in human food. Once the debris penetrated into the soil, its 'availability' to plants was greatly reduced. Consequently, the accumulation of available strontium-90 in the soil since nuclear weapon testing commenced in 1945 had been slight.

The radioactivity of milk was highest in western areas of Britain and appeared to be related to the distribution of rainfall. The level of radioactivity increased in all areas during the latter half of 1958, partly as a result of an unusually high rainfall and partly of an increase in the number of nuclear tests.

Examination of certain upland areas that are characterized by high rainfall and by slow growth of herbage had shown that milk from these areas often contained very high levels of strontium-90. This could not be accounted for entirely on the basis of high rainfall, low soil-calcium, and low production of herbage per acre. It was thought that strontium-90 must become entrapped in the mat of vegetation and roots at the base of the sward, and be held available to the plant in successive seasons, in a way not observed on lowland pastures.

The report shows that when strontium was absorbed from the diet, it tended to replace calcium in bone tissue. High levels of strontium-90 in bone could damage the bone or bone marrow, ultimately causing tumours, leukæmia, or other bone diseases. However, it appeared that the replacement of calcium by strontium-90 in new bone tissue was governed not by the amount of strontium-90 in the diet but by its proportion relative to calcium (expressed as micro-microcuries of strontium-90 per gm. calcium). Furthermore, the human body, in absorbing mineral substances from the digestive tract, discriminated against strontium, so that the ratio of strontium-90 to calcium which was found in bone was only one-quarter of that in the food eaten.

The report also discusses other factors which tended to reduce the ratio of strontium to calcium in the diet. Thus, the cow discriminated against strontium when producing milk from grass, so that the proportion of strontium-90 to calcium in milk was only one-seventh of that in the herbage eaten. Leafy vegetables appeared to absorb strontium less efficiently than herbage, and contained correspondingly less radioactive material. Although wheat contained a fairly high proportion of strontium-90, milling, as in the preparation of white flour, removed much of the calcium and strontium in bran and offal, while the subsequent addition of strontium-free chalk as a calcium supplement further reduced the proportion of strontium to calcium in bread and flour products. The report noted that the ratio of strontium-90 to calcium in diets based on wholemeal bread was likely to be higher than average, as there was no legal requirement to add chalk to wholemeal flours, while the milling process did not tend to remove any of the strontium contained in the grain.

However, even on the most unusual food and living in the wettest area, no one in the United Kingdom was likely to consume a diet containing more than 23 μμc. of strontium-90 per gm. calcium, about half the ratio (40 μμc.) at which a Medical Research Council Committee thought that 'immediate consideration' should be given to the problem. It is emphasized that no evidence had been found of such a diet being consumed by anyone. The amount of strontium-90 per gm. calcium in the average diet was about 6 μμc., and, provided that the rate of deposition of the radioactive dust did not greatly increase in the future, either as a result of meteorological factors or because of further testing of nuclear devices, such a level should give no cause for anxiety.

J. M. A. TILLEY

IMMEDIATE AND LOW-LEVEL EFFECTS OF IONIZING RADIATIONS

THE biological effects of low doses of ionizing radiations, a topic of obvious interest and importance, formed one of the main themes of a symposium held in Venice, June 22–26, under the joint sponsorship of Unesco, the International Atomic Energy Agency and the Comitato Nazionale per le Ricerche Nucleari of Italy. The Organizing Committee included Prof. Z. M. Bacq (Belgium), Profs. E. Boeri and A. A. Buzzati-Traverso (Italy), and Dr. A. Hollaender (United States). Those invited were fortunate in being able to take part in a conference of which content and programme arrangements were of a high order, and which was held in the beautiful surroundings of the Fondazione Giorgio Cini, on the Isola di San Giorgio Maggiore. Each of the nine sessions was arranged to contain only a few papers, so that there was ample time for discussion and for a few short communications which were relevant to the main themes. Sixteen countries, and a wide range of scientific disciplines, were represented among the 116 research workers who took part.

The symposium opened with a review of certain aspects of quantitative radiobiology by K. G. Zimmer (Kernreaktor, Karlsruhe, Germany). After discussing critically some of the postulated mechanisms of the biological action of ionizing radiations, he went on to describe recent results obtained by the use of microwave spectroscopy This topic, discussed also by J S Kirby-Smith (Oak Ridge, United States), is of great interest because persistent magnetic centres can be observed in irradiated biological materials of low water content, and the signals are modified by environmental factors which are known also to modify the biological effects of radiation However, caution is necessary in interpreting the results obtained by instruments currently in use, since the signals observed arise from about 10^{10} times as many ionizing events as those which in many cases initiate biological damage

New techniques which have recently been developed for studying cells in mitosis have enabled investigators to undertake the difficult task of observing quantitatively the induction of chromosomal abnormalities in human cells M A Bender (Oak Ridge, United States) had examined effects on human cells in tissue culture, and also on monkey cells *in vivo*, using bone marrow The cells irradiated *in vivo* gave a somewhat lower yield of chromosome aberrations Doses down to 25 r were used in these studies

The effects of considerably lower doses on human cells were observable by M Ingram (University of Rochester, United States), who had found significant increases in the number of binucleate lymphocytes present in the blood of persons exposed to doses considered to be in the 'tolerance' range Although ionizing radiation is not the only agent which can bring this about, it was of interest that in a field investigation of uranium miners, a higher count of binucleate lymphocytes was found in the blood of the control group of coal miners, who had been subjected to regular routine diagnostic X-ray examination [1] Another paper on effects of X-irradiation on the blood picture of mammals was given by S Hajduković (Institute for Nuclear Sciences, Yugoslavia), who used as his test effect the increase in the number of reticulocytes released into peripheral blood He reported that increases were also obtained when serum from irradiated animals was injected into non-irradiated ones, the effect not being species-specific These changes were observed fairly early after the irradiation

The subject of chemical protection against biological effects of ionizing radiation was reviewed by D W van Bekkum (National Defence Research Council, Holland), who discussed different groups of protective substances and critically examined possible mechanisms of action R Brinkman (State University, Groningen, Holland) described techniques for examining the protective effect of chemicals against radiation-induced changes which could be measured very soon after low doses of irradiation These included measurements of the viscosity of synovial fluid, and of intradermal pressure Effects of irradiation could be observed within one second, and serotonin injected intradermally was the most effective of the protective substances used M Ebert and A Howard (Medical Research Council and British Empire Cancer Campaign, Great Britain) described some of their latest findings with inert gases These gases suppressed the enhancing action of oxygen when used at pressures above atmospheric, but were less effective in the cold than at room temperature J F H Maisin (University of Louvain, Belgium) had found that small doses of radiation could themselves protect against the damaging effect of larger doses Yeast cells were exposed for long periods to continuous irradiation which was not itself sufficient to kill the cells , thereafter, larger doses were required to produce a given killing effect on these than on control cells Rats which had been exposed to radiation *in utero* or as new-borns were more resistant than controls to radiation given afterwards

Various types of immediate response to irradiation had been observed by O Hug (International Atomic Energy Agency, Austria), who showed a film which demonstrated reflex reactions of snails, sea urchins and ants It was clear that an immediate effect of radiation could be observed with nerve tissue, long thought to be comparatively insensitive to its action A different type of immediate response was reported by A Forssberg (Institute of Radiophysics, Sweden), who has observed reversible effects of doses as low as 10^{-3} r on the fungus *Phycomyces blakesleeanus*, the growth-rate of the sporangiophore being immediately reduced Depression of growth-rate was accompanied by an increase in the level of acid-labile phosphorus, and a slightly delayed increase in lactic acid It was suggested that the use of adenosine triphosphate might be blocked by the radiation

Radiobiologists continue to search for the biochemical links between the absorption of ionizing energy and the manifestation of the effects observed, and various approaches were reported P Alexander (Chester Beatty Research Institute, Great Britain) gave an account of physico-chemical studies on effects of radiation on deoxyribonucleic acid *in vitro* and in herring sperm, including a discussion of the phenomenon of cross-linking K I Altman (University of Rochester, United States) had studied the breakdown of muscle collagen in rats previously fed with labelled amino-acids Whole-body irradiation with lethal doses was followed by a reduction in the hydroxylation of proline and an increase in that of its precursor

A Chevallier and S Manuel (University of Strasbourg, France) found that one result of radiation which could be measured within a short time was a drop in the ascorbic-acid content of almost all tissues, particularly the spleen While this was true of animals irradiated as a whole, spleen slices irradiated *in vitro* did not demonstrate the phenomenon, nor was it observed when only the exteriorized spleen was irradiated The authors concluded that the drop in ascorbic acid in the spleen depended on effects on other organs P Mandel and P Chambon (University of Strasbourg, France) reported studies on ribonucleic acid synthesis in rat spleen after whole-body irradiation Accumulated nucleotides were found in this organ from 12 hours after irradiation R Goutier, M Goutier-Pirotte and P Ciccarone (University of Liège, Belgium) examined an effect which occurred soon after the comparatively low dose of 150 r (whole-body) to rats Changes in the deoxyribonuclease activity of the spleen could be detected after half an hour The activity of the extracted enzyme depended critically upon the methods used in preparing the sample The authors considered that the effect was due to a change in the enzyme molecule, and not to the effect of the irradiation on enzyme distribution

H I Adler (Oak Ridge, United States) reported on observations with a variant of *Escherichia coli* which did not synthesize catalase One effect of irradiation was to sensitize the cells to the action of hydrogen peroxide Irradiated cells exposed to its action were killed, although they would otherwise have survived

Bacteria were used in two studies of the effects of low doses of radiation Marcovich (Institut du Radium, France) had examined the induction of lysogenic bacteria, and concluded that the passage of a single ionizing particle through a cell was sufficient to bring about this effect M Demerec (Carnegie Institute of Washington, United States) made use of three biochemical mutations which occurred spontaneously with very low frequency, so that the genetic effects of doses as low as 8 5 r could be assessed In all three cases, the number of mutations induced was proportional to the dose at low doses, though the doses required to produce a given frequency of mutations differed for the three mutations chosen for study

New observations on the genetic effects of ionizing radiation on mice were reported by W L Russell (Oak Ridge, United States) These have confirmed his previous report that if a dose in the range 200–600 r was delivered at 80 r /min more mutations were induced in spermatogonia than if the same dose was delivered continuously as 'chronic' irradiation at 90 r /week or less This did not apply to mutations induced in spermatozoa The genetic effect of a single dose on oocytes was greater than on spermatogonia, whereas the reverse was true of chronic irradiation L B Russell (Oak Ridge, United States) reported that chronic irradiation was less effective than an acute dose, delivered to embryos in their most sensitive stage, in bringing about still-births and neonatal deaths

Various tests of radiation damage were used by L J Cole (Naval Radiobiological Defense Laboratory, United States) in comparing effects of single exposures and 'chronic' or fractionated radiation Single doses were less effective in inducing leukæmia or shortening the life span , but the effects of chronic irradiation doses on the fertility of female mice were much lower than were single doses The effect of as little as 25 r in a single dose could be detected in weanlings The injection of bone marrow, which protected against the lethal effects of 800 r , did not protect against loss of fertility

Immunological aspects of tissue transplantation after 300 r of X-rays had been studied by P C Koller and S Doak (Chester Beatty Research Institute, Great Britain) After fifty days, the immune response of some 'chimaeras' had reverted to the host type, others had retained the immunity of the donor, and yet others gave a mixed response

This very brief account of the subjects discussed at the symposium should make it evident how wide a range of materials, and how many different approaches, are being used in attempts to clarify some of the outstanding problems in radiation biology The proceedings of the symposium are to be published as a supplement to the *International Journal of Radiation Biology* TIKVAH ALPER

NUCLEAR FORCES AND THE FEW-NUCLEON PROBLEM

MORE than 250 nuclear physicists, including about 100 delegates from fifteen countries overseas, attended the international conference, which was held at the Physics Department, University College, London, during July 8–11 A conference on the behaviour of light nuclei had not taken place for several years and was initiated by physicists at Los Alamos and University College. As was stressed by Prof H S W Massey (University College), who opened the conference, although the original intention was to emphasize the few-nucleon problem, discussion of nuclear forces had inevitably to be included

The conference consisted of five main sessions, the first and longest being entirely devoted to the primary two-nucleon interaction In this session review papers were given by Profs R E Marshak (Rochester), R Wilson (Harvard), K A Brueckner (Pennsylvania) and G F Chew (Berkeley) on both the experimental and theoretical status of the problem Interest centred on many sets of measurements, including triple scattering and correlation experiments, as well as more accurate cross-section measurements at various energies and on their interpretation in terms of the S-matrix Prof G Breit (Yale) presented an extensive search for phase-shift fits to the scattering data up to 340 MeV , while comparison was made with phase-shifts derived from various phenomenological potentials by Prof Marshak There was discussion on both the necessity and theoretical justification for including spin-orbit and other velocity-dependent potentials in the two-body force The experimental papers were concerned with recent triple scattering measurements in p–p scattering at Rochester and Harwell and with p–p angular distributions at Minnesota Also n–p angular distributions and polarization measurements from 20–120 MeV were reported by Dr J J Thresher (Harwell)

Dr J Iwadare (Kyoto) summarized the recent work done in Japan on the meson-theoretical two-nucleon interaction and its comparison with experimental data This was followed by Prof Chew's paper, which reviewed recent work on the meson field-theoretical approach to the two-body problem starting from the Mandelstam conjecture on the analytical form of the scattering amplitude The inclusion of the pion–pion interaction within the context of dispersion relations seems to be the next step in the long struggle to obtain meaningful results from the meson theory of nuclear forces proposed by Yukawa in 1935

Prof Yukawa was chairman for the beginning of the second session, on the scattering of nucleons by light nuclei at high energy A review paper on the impulse approximation by Dr H McManus (Chalk River) was followed by applications of this approach to the n–d and p–d case by Drs L Castillejo (Birmingham), R Phillips (Harwell) and by Japanese workers The problem was examined from the point of view of dispersion theory in a paper by Goldberger, Halpern and Blankenbecler (Princeton), and corrections due to multiple scattering were considered by Prof R J Glanber (Harvard) In this session there were reports by Drs A M Cormack, T C Griffith and G Huxtable on experiments done at Harvard, University College and Harwell respectively on p–d and p–α scattering at energies between 50 and 150 MeV

The session on photonuclear reactions with light nuclei opened with a review by Dr D Dixon

(Glasgow). Other papers were presented by Profs. G. Breit, A. Klein (Pennsylvania) and Dr. Iwadare. The effect on the theory of the photodisintegration of the deuteron of the spin-orbit force within the n–p system stimulated much discussion.

The fourth session of the conference was devoted to the question of binding energies and elastic scattering of light nuclei at low energies. The review papers were given by Prof. H. S. W. Massey and Dr. P. G. Burke (University of London) on the three-body problem and on the elastic scattering of nucleons by alpha-particles. There were also two invited papers from Los Alamos. Dr. L. Cranberg reported on experimental results concerning total and differential cross-sections and also polarization measurements in the scattering of low-energy neutrons from ^{2}D, ^{3}H and ^{3}He, while Dr. L. Rosen reported on charged particle scattering from ^{2}D and ^{3}H at energies up to about 20 MeV. These experiments led to several new checks on charge symmetry and time reversal invariance.

The contributed papers included one on the ground-state energy of the triton, by Prof. J. M. Blatt (Sydney). Using the Gammel–Thaler potential, no bound state was found for reasonable trial wave functions. Among other papers from Los Alamos, Dr. J. L. Gammel gave a preliminary account of attempts to integrate the n–d problem numerically and discussed the feasibility of spin-correlation experiments using ^{4}He as an analyser.

Polarization measurements in n–d and p–d scattering at low energies, reported by Dr. H.-J. Gerber (Zurich) and Dr. R. E. Segel (North-western University), indicate that there is very little polarization at about 4 MeV. A contribution from Dr. N. Vlassov (Moscow), read by Dr. I. A. Baz, on the interaction of protons and deuterons with light nuclei ended this session.

The last session, with a title "Reactions Involving Four or More than Four Nucleons", was opened by Dr. B. H. Bransden (Glasgow) with his paper on the collisions of neutrons and of deuterons with ^{3}H and ^{3}He. This paper was followed by a number of papers involving the application of the resonating group structure method to binding energy and scattering calculations. This method, as did the impulse-approximation method at higher energies in a previous session, aroused considerable controversy during the discussion. Nevertheless, it was felt that some progress had been made, since one type of mixture of exchange forces does seem to be simulating the exact force in more than one situation involving light nuclei.

Prof. G. Skornyakov (Moscow) then gave his paper on n–d scattering in the zero-range force approximation, this being a contribution to the previous session. The three-particle problem is solved accurately in this limit. He also read a paper by Dr. T. Y. Barit on p–T scattering and allied reactions.

The final papers were preceded by a review given by Dr. V. J. Emery (Harwell) of the calculations of the binding energies of nuclei using the Brueckner method. Prof. Brueckner himself also presented a paper on the Hartree–Fock method for strongly interacting systems. The conference concluded with papers by Profs. N. Austern and S. Meshkov (Pittsburgh) on preliminary calculations concerning the structure of ^{6}Li and ^{12}C.

T. C. GRIFFITH
E. A. POWER

CHAGAS'S DISEASE

CHAGAS'S disease or South American trypanosomiasis, occurring chiefly in Brazil and other countries of South America, is caused by *Trypanosoma cruzi* and is spread mainly by reduviid bugs. The disease was first discovered and described fully in 1909 from the State of Minas Geraes in Brazil. All the significant observations regarding the causative agent, the vector, mode of transmission and symptoms were made then, by that creative genius, Carlos Chagas. In order to commemorate the fiftieth anniversary of this discovery, an international congress on Chagas's disease was held at Rio de Janeiro during July 5–11.

Foreign delegates from European countries, Israel and the United States of America numbered more than seventy. Approximately 300 others from Brazil and the neighbouring countries of South America also attended. At a short historical session at the Ministry of Education and Culture on July 4 the life and work and significance of the discoveries made by Chagas were described by various speakers.

The inaugural meeting of the congress was held on July 5 in the National Faculty of Medicine from 9 p.m. until midnight, when addresses were delivered by Prof. Alessandri (Chile), Prof. Lemoigne (Pasteur Institute, Paris), Dr. Candau (director general, World Health Organization), a student in the Medical Faculty, Prof. Moraes, director of the Medical School and dean of the University, and replied to by Prof. Carlos Chagas Filho.

The real business of the congress began on the following morning at 9 a.m. and lasted until 6 p.m. in a pavilion within the grounds of the Instituto Oswaldo Cruz. Two or three sessions took place concurrently to discuss the disease in its different aspects. In one of the lecture theatres simultaneous translations from English, French, Spanish, Portuguese and German were provided. Chagas's disease in the American continent was discussed from the pathological aspect and the different forms encountered in the various South American countries described, including the clinical findings on the two human cases thus far reported from the southern United States. Other papers on transmitting agents, animal reservoirs, including the opossum and armadillo, and their relation to the epidemiology of the disease as well as the characters of the human strains, were discussed. Public health questions were reviewed in relation to the geographical distribution of the principal transmitters of the disease which infest human dwellings. The anatomy and respiratory system of *Triatoma infestans*, the chief vector in Brazil, was described. On the following day the subject discussed in one section was the ætiological agent, with emphasis on the physiology, metabolism and nutrition of the parasite. Electron microscope studies of parasitized cells were included. In another section immunological aspects of the disease, including complement fixation reactions, precipitin and skin tests, were dealt with and the isolation of immune polysaccharides from the organism described. The occurrence of toxins in cultures of the organism appeared to be doubtful. The epidemiology of the disease was discussed in seven papers. Polymorphism which occurs in African trypanosomes was compared with that met with in *T. cruzi*, and observations made on the nature of their evolutionary cycles. The session was concluded by the showing of a film dealing with methods of eradication of the tsetse fly, which transmits the disease in Portuguese Africa. On the same evening a meeting was held in the Brazilian Academy of Sciences from 9 p.m. until midnight, at which a paper was read on "Chagas as Protozoologist", and others on the metabolism, phylogeny and growth of the parasite. The following day was devoted to the pathology of acute and chronic cases of the disease in different parts of the South American continent, throughout which the virulence of the causative agent varies. Discussions took place on the myocardial, nervous, cerebrovascular and blood protein changes involved, as well as on the condition of megacolon and megaœsophagus now believed to be causally related to the disease. Further papers on epidemiology dealt with animal reservoirs and with the feeding habits of domestic and wild types of reduviid bugs. The danger of blood transfusion as a means of spread was also dealt with. Prophylaxis was best effected by spraying the sites where the vector was found, along with general hygienic measures. Workers from different areas of South America, where the nature of the problem varies with the transmitting agent, contributed also on the following day. The different clinical forms and diagnosis of the disease, including that met with in congenital cases, were described in seven papers. At a special session the nature of the infection caused by *Trypanosoma rangeli* was described. This parasite was first described in 1920 by Tejera in Venezuela, where it infects *Rhodnius prolixus*, which is also the chief transmitter of *T. cruzi* there. The first forms were seen in human blood in Guatemala in 1946, and now 795 cases of infection have been described in Venezuela, chiefly in children, but the infection is not of serious character. At an evening session in the National Academy of Medicine further papers were read. On the last full working day of the congress, eighteen papers were read, chiefly on the relationship of cardiac and nervous disorders, including megacolon and megaœsophagus, to Chagas's disease. Discussions also took place on chemotherapeutic agents, but the sad fact remains that no curative agent is known for this disease. A short ceremony took place during the morning at which a plaque, presented by the Argentinian delegation, to the memory of Carlos Chagas was unveiled.

On the same day a paper was read by Prof. Jean Coudert on the action of *T. cruzi* extracts on cancer cells, another by William Frye on antibiotics in tropical disease, and Rene Dubos gave a talk on general aspects of infection.

The final meeting on July 11 was devoted to round-table discussion of the subjects dealt with earlier in the week. Resolutions were also submitted regarding the holding of another international congress within the next few years, but no definite decisions were arrived at. During the week more than 150 papers were read. Two medals were struck to commemorate the congress, each with the head of Carlos Chagas on one side, but differing on the obverse side. The proceedings of this inspiring congress will be published in due course.

J. D. Fulton

SPECIAL CERAMICS

The challenge of temperature, which has inspired the metallurgist to some of his more notable developments, has in recent years been renewed and has been taken up by the ceramist, who is seeking materials of low creep resistance, high thermal shock resistance and high hot-strength to meet the demands of propulsion engineering, high-speed vehicles and nuclear engineering. The ceramist has for many years made his own special contribution to communications engineering, chiefly in the exploitation of oxide-type materials; the field of non-oxide materials remained largely unexplored, but it is now being opened up by the drive for new materials in other engineering applications. The British Ceramic Research Association has for the past five years had a small group devoted to these studies and has been working in close co-operation with various Service departments and industrial concerns. It was felt that some attempt to set up a forum for the exchange of ideas would be timely, and the outcome was a Symposium on Special Ceramics held at the Laboratories of the British Ceramic Research Association in Stoke-on-Trent during July 13–15. About 150 delegates attended the symposium and seven countries were represented. The subject-matter of the symposium was divided into four sessions dealing with (1) properties and structure, measurements; (2) preparation and properties of nitrides; (3) preparation and properties of other non-oxides; and (4) furnaces, techniques, analysis, applications, etc.

After a welcome to the delegates by the chairman of the Association, Mr. E. James Johnson, and the director, Dr. A. T. Green, the deputy director, Dr. N. F. Astbury, gave an introductory lecture on the fields of application for new ceramic materials, and spoke of the special ceramics research programme of the British Ceramic Research Association, in which particular reference was made to boron nitride, a machinable dielectric capable of withstanding high temperatures, and to a new form of self-bonded silicon carbide and to silicon nitride. Both the latter materials are being actively studied in connexion with rocket engineering. The dependence of macroscopic properties on crystal structure and the trends observed in groups of materials of the same structure were discussed in a paper by Dr. S. N. Ruddlesden (British Ceramic Research Association), who illustrated her arguments by non-oxides such as silicon nitride and boron phosphide, the latter being a new compound of the III–V series of zinc-blende structures. Like silicon carbide, boron phosphide is very hard and it is a semiconductor with an energy gap of the order of 5 eV.

The greatest challenge that ceramics must face in meeting metals in their chosen field is the absence of ductility and their comparatively low breaking strain. The reply to this is being sought by a study of the properties of certain oxide crystals, and it was of special interest, therefore, that Dr. F. J. P. Clarke (U.K. Atomic Energy Authority, Harwell) was able to give an account of his experiments on the room-temperature ductility of single crystals of magnesium oxide, together with his observation of slip bands and fracture starting at the intersection of these slip bands near a crystal face Dr Clarke discussed possible applications of his results to polycrystalline materials

Methods of measuring thermal conductivity requiring much less time than traditional methods were described by Mr T W Lindop (Morgan Crucible Co), and Mr R P Tye (National Physical Laboratory) contributed to the discussion with an account of an even more rapid (< 1 min) comparator method A simple apparatus for the measurement of creep at high temperature (1,200° C) was described in a paper by Messrs N L Parr and G F Martin, read by Mr D M Rae (Admiralty Materials Laboratory) Dr Clarke ended the first session with a description of the effect of reactor irradiation on ceramic materials, which aroused some lively discussion on the damage mechanism and the neutron energies causing most damage.

Silicon nitride is a hard, very strong material (the modulus of rupture at 1,200° C is of the order of 18,000 lb /sq in) which can be made into shapes of accurate dimensions by nitriding pressed silicon-powder, since no contraction occurs during the firing Its preparation, its properties as an engineering material (it possesses very good thermal shock resistance and satisfactory resistance to creep) and its microstructure were described by Messrs N L Parr, G F. Martin and E R W May (Admiralty Materials Laboratory) In the subsequent discussion, Mr P Popper (British Ceramic Research Association) showed photographs of some intriguing spiral 'whiskers' of silicon nitride A new hexagonal form of Be_3N_2 was described by Drs A Rabenau and P Eckerlin (Philips, Aachen), who had studied the system Be_3N_2—Si_3N_4 and found two other compounds, Be_4SiN_4 and a wurtzite-type compound, $BeSiN_2$

There is a wide gap between organic plastic insulators, which can be easily shaped by moulding or machining but which cannot withstand high temperatures, and refractory insulators, which can withstand very high temperatures but are difficult to make to accurate dimensional tolerances One material which helps to bridge this gap is boron nitride, a refractory insulator which can be easily machined, a property which is attributed to its layer lattice crystal structure, which resembles that of graphite, with which it is isosteric It is not wetted by many molten metals and has a high electrical resistivity (10^6 ohm cm at 1,300° C) and high resistance to chemical attack The preparation of boron nitride, its possible uses, the control of hot-pressing and stability by additions of 'impurities' were described by Dr T A Ingles and Mr Popper (British Ceramic Research Association) Other possible materials to bridge the gap are being sought in polymers which contain boron and nitrogen or phosphorus and nitrogen The paper by Messrs F W Ainger and I M Herbert (Plessey Research Laboratories) on the preparation of phosphorus–nitrogen compounds as non-porous solids was remarkable for the presentation of so much inorganic chemistry in the language of the organic chemist

Knowledge of dissociation pressures is important in considering materials for high-temperature applications, and measurements of the dissociation pressures of metallic silicides and of silicon carbide were reported by Mr P Grieveson and Dr C B. Alcock (Imperial College of Science and Technology), who interpreted their results on a thermodynamic basis A novel way of preparing an extremely strong, dense silicon carbide, without the need for hot-pressing, was described by Mr P Popper The method involves heating a cold-pressed mixture of carbon and silicon carbide powder in an atmosphere of silicon vapour when, under appropriate conditions, a material is obtained with a density of 3 05 gm /cm ^{3} (corresponding to 95 per cent crystallographic density) and a modulus of rupture at room temperature of the order of 30,000 lb /sq in Another silicide, $MoSi_2$, described by Mr J B Huffadine (Plessey Research Laboratories), has a very low electrical resistivity and is used in heating elements It has a remarkably high oxidation resistance and an expansion coefficient substantially the same as alumina, from 0° to 1,000° C It also adheres strongly to alumina if hot-pressed with this oxide, and it was suggested that composite $MoSi_2$—Al_2O_3 pressings could provide useful electrical components

The preparation and properties of calcium fluoride ware were described by Mr P Rado (Worcester Royal Porcelain Co) Although this material has a very poor thermal shock resistance, it has found application as a crucible material for the reduction of metallic fluorides, particularly uranium fluoride

Photoconductive materials have normally been used in the form of single crystals, but Drs W van Gool and J G van Santen (Philips, Eindhoven) showed that a polycrystalline aggregate of cadmium sulphide could be used as an element in photosensitive devices

Throughout the symposium attention was repeatedly directed to the high-temperature techniques required in the preparation of special ceramics, and some of these were discussed in detail in the final session, which included three papers on furnace design Dr A Z Borucka (Metals Research, Ltd) described the construction of a furnace to give a hot zone (1,200° C) of very uniform temperature by having the furnace windings split into several sections with the spacing of the windings graduated in each section Dr M Cole and Dr Borucka (Metals Research, Ltd) described a novel replaceable heating element, consisting of a molybdenum heater encased in an alumina sheath through which hydrogen or another protective gas is passed These elements can heat a furnace with a capacity of several cubic feet to 1,800° C in either oxidizing or reducing atmospheres, giving a uniform temperature distribution with no contamination of the furnace atmosphere The construction and advantage of various types of carbon-tube furnace, that is to say, the simple tube, the single-ended, hairpin-cut tube and the spiral-cut tube, capable of operating at temperatures above 2,000° C *in vacuo* or in controlled atmospheres, were described by Mr C J W Baker (British Ceramic Research Association)

Many of the special ceramic materials cannot be melted under normal conditions, and so sintering cannot be used as a means of densification The alternative technique is hot-pressing, but this has the disadvantage in general that only simple shapes can be produced without further machining Dr J S Jackson and Mr P F Palmer (British Thomson-Houston Research Laboratories) described an apparatus designed for hot-pressing small specimens of refractory hard materials to high density in graphite dies heated by passing a high current through the walls They reported the contraction of various carbides, borides and oxides as a function of temperature, and showed that reduction of particle size reduced the temperature needed for densification

One of the difficulties of powder aggregation is the variation in density which may occur through the compact This difficulty can be circumvented by isostatic pressing, and the use of a reversible gel, such as a polyvinyl polymer, as a mould material giving substantially true hydrostatic pressures up to 50 tons/in ^{2} was described by Mr T W Penrice (Production Tool Alloy Co) The technique is evidently applicable to quite complicated shapes

The analyst's outlook on the new materials was touched upon in a paper by Mr H Bennett (British Ceramic Research Association) on the chemical determination of nitrogen in refractory nitrides, which posed many new problems The final paper was a description by J Peyssou (C S F, France) of the possible variations of properties of ceramic articles caused by variations in firing conditions and methods of manufacture

The symposium concluded with a tour of the laboratories of the British Ceramic Research Association The proceedings of the symposium are to be published by Heywood and Co as a book, "Special Ceramics", which is being edited by Mr P Popper

N F ASTBURY

SOLID STATE PHYSICS

A CONFERENCE was held at Melbourne on "Solid State Physics" during August 17–21 under the auspices of the Australian Branch of the Institute of Physics Grants from Australian industry, learned societies, government organizations and universities and support by the United States Government research authorities, the United Kingdom Atomic Energy Authority and the Canadian Government enabled several Americans, a Canadian and three Englishmen to attend Other States of the Commonwealth of Australia and New Zealand were well represented

The matter was drawn from across almost the whole range of this enormous subject, and one could hope that it might set a style of conference where the programme would be not so specialized that only a few experts could really benefit

The programme opened with a day devoted to low-temperature properties of metals and alloys Precision lattice parameters, superconductivity and superfluidity, dislocation-phonon scattering and electron phonon drag effects were discussed The changes of lattice parameter in bismuth on alloying set a challenge to the theorists, and the dislocation scattering of phonons seems still to be in error by a factor assessed as between three and seventy by one speaker

Electron field emission, low-energy sputtering, epitaxial growth and dislocation barriers at surfaces served during the next day to remind those present just how little of the surfaces of solids is understood The afternoon and following day were devoted to plasticity studies, when softening by adiabatic heating was used to explain the serrated load extension curves of iron at temperatures immediately above the brittle fracture region, as well as for aluminium at very low temperature The dependence on orientation of work hardening and of slip-system geography in face-centred cubic metals were presented, and it was clearly the opinion of the majority that current theories are far too simple in their outlook The Peierls–Nabarro force, its connexion with lattice friction, and the significance of the friction term in the hardening curves formed a recurrent theme in and out of the lecture room Preliminary results indicate that reliable twin-fault densities may be obtained from the asymmetry of Bragg peaks and this may inject a little more knowledge of the deformed state Measurements of the mechanical properties of the alkali metals at very low temperatures, along with optical microscope studies, have confirmed the X-ray evidence of shear transformations in sodium and lithium, and have brought to light a great sensitivity to structural details in the transformation of the crystalline aggregate

On the third day attention was swung to optical properties of solids, with papers on soft X-ray studies of the light metals, infra-red and optical absorption in ionic crystals Dielectric properties of doped alkali halides, evidence for aggregation of *F* centres and new techniques and facts in luminescence studies were the subjects for the remainder of the day The analysis of rare-earth spectra in crystals is getting steadily more detailed and very large-scale calculations are rapidly elucidating the details of interactions within the *f* electron-shell

The last day saw an interesting mixture of papers the dreadful maze into which theoretical physicists lead each other when the anharmonic terms leading to thermal expansion are studied was on show, as was the theory of zone structure in liquids Here some progress seemed to be made for the one-dimensional model The magnetic structure of metallic chromium and its alloys was discussed in terms of magnetic properties and neutron diffraction evidence Then came the grand finale with one situation well on the way to elucidation and three well on the way to confusion The ordering of α-brass at temperatures of about 135° C has been most convincingly shown and will probably remove the few remaining anomalies in the properties of the αCu—Zn phase in this temperature region But in copper the first annealing observed after very low-temperature bombardment now occurs at only 7° K, and the atomic processes involved get steadily more mysterious Polycrystalline calcite or 'marble' plastically uni-axially compressed at high hydrostatic pressure, largely recovers its axial dimensions on release of the hydrostatic pressure In lithium fluoride as well as silicon iron, plastic hardening seems to denote a drop in dislocation speed under a given stress, indicating an increase in dislocation viscosity—or is it a drop in effective stress ?

It was a stimulating conference, and those from overseas were impressed to find such a wealth of first-class work, enthusiasm and hospitality in this rapidly growing and developing continent of Australia.

W M LOMER

UNIVERSITY GRANTS IN GREAT BRITAIN

THE annual returns from universities and colleges in receipt of Treasury grants from the academic year 1957–58, now covering twenty-one universities and three colleges, issued by the University Grants Committee, records a further increase in the number of full-time students to 95,442, compared with 89,866 in 1956–57 (Pp 54 Cmnd 832 London H M Stationery Office, 1959 5*s* net) Statistics collected in October 1958 showed a university population of about 100,000, and this number is expected to reach at least 110,000 by 1961–62 There were 6,180 full-time and 2,208 part-time students from overseas within the British Commonwealth and 3,982 full-time and 1,904 part-time students from foreign countries, for 1956–57 the corresponding figures were 6,115 and 2,016 for the Commonwealth and 3,792 and 1,756 for foreign countries Of full-time new students 36 4 per cent were in arts, 23 7 per cent in pure science, 19 0 per cent in technology and 13 7 per cent in medicine these figures compare with 38 7, 15 2, 13 5 and 26 1, respectively, in 1938–39 For full-time women students the corresponding figures for 1957–58 are 63 5, 20 0, 0 8 and 12 1, respectively, and for 1938–39, 64 7, 15 9, 0 8 and 16 2 Full-time advanced students of pure science numbered 3,853 (34 8 per cent), of technology, 1,916 (17 3 per cent), and of medicine, 968 (8 8 per cent), 3,007 students were taking postgraduate courses in teacher training

Of the full-time students 76,687 were reading for a first degree, 3,937 for a first diploma and 14,069 engaged in research or other advanced work, the corresponding figures for 1956–57 being 71,713, 3,969 and 13,379, respectively Of the new full-time students, 24 0 per cent were in pure science, 15 4 per cent in technology and 9 3 per cent in medicine, for 1956–57 the corresponding figures were 23 8, 15 0 and 9 6 per cent, respectively

The proportion of assisted students was 79 2 per cent compared with 75 7 per cent in 1956–57 and 71 9 per cent in 1953–54, ranging from 92 2 per cent in Wales, 86 7 per cent in English universities, excluding Oxford, Cambridge and London, to 67 2 per cent for Scotland Full-time teaching and research staff increased to 10,542, compared with 10,485 in 1956–57 The proportion of full-time students residing in colleges or halls of residence was 26 4 per cent compared with 27 4 per cent in 1956–57 although the total, 25,174, was higher The proportion of men in residence, excluding Oxford, Cambridge and London, was 22 4 per cent and of women, 38 6 per cent, whereas 46,237 (48 4 per cent) were in lodgings and 24,031 (25 2 per cent) at home, compared with 46 per cent and 26 6 per cent, respectively, the previous year

Of the recurrent income of £49,418,302 (an increase of £7,762,693 on 1956–57) £34,953,406 was from Parliamentary grants (70 7 per cent) Income from fees increased from 11 2 per cent to 11 5 per cent, local authority grants decreased from 3 1 to 2 8 per cent, endowments from 4 0 per cent to 3 6 per cent, donations and subscriptions from 1 2 to 1 1 per cent, and payments for research (£3,008,898) from 6 5 per cent to 6 1 per cent Non-recurrent grants in respect of capital expenditure amounted to £11,816,479 compared with £9,134,185 in 1956–57 and of the recurrent expenditure of £48,335,053—an increase of £6,825,350 on 1956–57—7 1 per cent was spent on administration, 68 6 per cent on departmental maintenance and 12 5 per cent on maintenance of premises Expenditure on libraries increased from £1,620,958 to £1,821,943 but decreased to 3 8 per cent of the total

NUCLEAR RESEARCH IN AUSTRALIA

IN the sixth annual report of the Australian Atomic Energy Commission (Commonwealth of Australia, 1958 Pp 62 Sydney Australian Atomic Energy Commission, 1959), covering the year ended June 30, 1958, considerable space is devoted to the Commission's Research Establishment at Lucas Heights, which was officially opened by the Prime Minister of Australia, the Rt Hon R G Menzies, on April 18, 1958 During the period up to the beginning of May approximately 4,500 visitors went to the Establishment Many of the major buildings have been completed and this has enabled the research staff to return from Harwell and to begin to design and assemble equipment for their research projects The Commonwealth Government has approved a further building programme involving an expenditure of £1 6 million during 1958–59 and 1959–60 on new laboratories and services, including engineering research laboratories, a building in which the fabrication and chemistry of beryllium fuels can be studied, and post-irradiation handling equipment

The report details the work of the principal sections of the Establishment and the various research projects to be undertaken The main function of the Isotopes Section is the advisory service to industry and research, and 310 requests for advice on various aspects of isotope production were dealt with during the year Australian industry and research in comparison with the United States of America or the United Kingdom has, however, been slow to accept the use of radioisotopes The Section assisted in a large-scale field test, in which a radioisotope technique was used to measure the efficiency of mixing in a cooling pond in an electrical power station Other investigations included the development of a method for the continuous investigation of moisture content of brown coal, a technique for tracing sewage sludge in sea disposal, siltation in the Hunter River, and the use of radioisotope tracers in cloud physics

A large proportion of the work of the Technical Physics Section has been concerned with the installation and commissioning of the control gear and instrumentation of the High-Flux Australian Reactor, at the Establishment Other equipment constructed and tested include a fast scaler, using transistors, with 'plug-in' scales of ten, and a discriminator with resolving time of 1 μsec, a beta-gamma coincidence unit, and linear amplifiers and scintillation counters for the Health Physics Section.

One of the aims of the fuel element research conducted at the Establishment is to develop a 'self-breeding' fuel in which thorium is present in such quantities that fissioned uranium is continuously replaced by uranium-235. Beryllium and beryllium oxide are also being studied as moderator materials and fuel carriers. Another problem under study is the production of graphite which is impermeable to fission product gases and several methods of sealing inherent porosity are being investigated. Research on a sodium-based liquid metal fuel reactor was begun at Harwell and is being continued at Lucas Heights. The experimental assemblies built by the Australian staff while at Harwell have been purchased and shipped to Australia. The sodium plant built by the Australian Atomic Energy Commission at the Research Establishment is a research tool designed to pump molten sodium at 500° C at 10 gall. per min. and it will provide facilities for carrying out research on compatibility problems, sodium component testing, heat-transfer investigations and the training of staff in the handling of liquid metals.

In the sections of the report dealing with the search for, and mining of, uranium details are given of the airborne radiometric and geological surveys carried out by the Bureau of Mineral Resources. There was a marked decline in interest in the search for uranium both by companies and individual prospectors. This is attributed to the uncertainty regarding the future of the world uranium market. The picture presented in the report is that of a rather difficult period in the years immediately ahead, but that the present rate of production could well prove insufficient within the next decade. The production of uranium oxide at Rum Jungle was lower than in the preceding year. Full-scale open-cut mining has been in progress at Mary Kathleen during the year and a large stock-pile of ore for treatment has been built up. A recalculation of the ore reserves of the Mary Kathleen deposit has shown that the total reserves of recoverable uranium oxide are greater than was originally thought and more than enough to complete the contract with the United Kingdom Atomic Energy Authority.

A symposium on the "Peaceful Uses of Atomic Energy in Australia" was held in Sydney during June at which 114 papers were presented. Brief details of the proceedings are given in the annual report, and a record of the papers and discussions is to be published. The publication of a new quarterly, *Atomic Energy*, giving information on developments in and applications of nuclear science and technology was commenced during the year, and the booklet entitled "Prospecting and Mining for Uranium in Australia" was reprinted. Six atomic energy exhibitions in various towns in the Commonwealth were presented by the Commission in addition to several television programmes at national and commercial stations in Sydney. The annual report concludes with a statement of the net expenditure of the Commission for the year ended June 30, 1958, details of the extra-mural research projects at various Australian universities, the names of the senior research staff and holders of the postgraduate research studentships and undergraduate scholarships, and a bibliography of the principal publications of members of the Commission, its staff and advisory committees.

CONSERVATION OF ENGLISH WALLPAINTINGS

In recent years those interested in early wallpaintings have been greatly perturbed by their condition and the rather haphazard methods sometimes employed for their preservation. It was therefore more than timely in 1953 for the Central Council for the Care of Churches and the Society for the Protection of Ancient Buildings to appoint a committee to report on the nature and causes of the troubles which have been observed in such paintings, the remedies which could be applied and the methods which would give the best hope of successful preservative treatment in the future. The report[*] was compiled under the able chairmanship of Mr. W. I. Croome. The committee included well-known archæologists and scientists who had made a special study of this problem.

At the outset the committee was seriously perturbed by the use of varnish and wax as a preservative, for these act as relatively impervious skins and impede the rate of evaporation of moisture and cause disintegration of the surface. As a preliminary measure it advised that these two methods should cease immediately.

The report continues with an instructive and necessary explanation of the technical terms and materials used in wallpainting. Then follows a useful summary of English and foreign practice in relation to wallpaintings with some pregnant notes on the effect of time. These clearly show that the conservation methods used were not satisfactory.

It was therefore abundantly clear that much fundamental work was necessary and the constructive recommendations of the committee are based on the practical applications of its conclusions.

The main recommendations deprecate the use of wax varnish, sodium silicate, or ethyl silicate for any preservative treatment. The use of caesin in a maximum 2 per cent solution in appropriate cases should be confined to the binding of loose pigment. Lime water should be used for the consolidation of the plaster foundation, and in the case of disintegration of the paint it may be mixed with skim milk. The committee stresses that since wallpaintings are liable to deteriorate under conditions of damp every care should be taken to make the church structurally sound and thus exclude any excessive moisture.

The committee feels that much further research should be undertaken on this problem and suggests a course of training which will eventually provide a succession of practitioners for this important work.

The report concludes with some practical notes for the removal of wax preparations, retouching and overpainting, recording and some excellent illustrations of work that has already been undertaken.

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[*] The Conservation of English Wallpaintings: being a Report of a Committee set up by the Central Council for the Care of Churches and the Society for the Protection of Ancient Buildings. Pp. 30+18 plates. (London: Central Council for the Care of Churches, Fulham Palace, 1959.) 7s. 6d.

KELLOGG AND NEY'S MODEL OF THE SOLAR CORONA

In an article in a recent issue of *Nature*[1], Profs P J Kellogg and E P Ney advance an entirely new theory of the solar corona The generally accepted explanation of the observed corona supposes that two components contribute to its light a K component due to Thomson scattering of sunlight by free electrons, which is the 'true' solar corona, and an F component due to diffraction scattering by dust lying between the Sun and the Earth The F component increases relative to the K component with increasing angular distance from the Sun The new theory suggests that the corona is an assembly of charged particles trapped by the Sun's magnetic field, analogous to the Van Allen belt of particles surrounding the Earth The contribution of the F component is regarded as much smaller than is currently supposed, and the continuous spectrum of the corona is thought to arise from synchrotron radiation as well as from Thomson scattering The authors suggest that the existing observations of the corona can be at least as well described by their model as by that currently accepted

Although the corona certainly shows puzzling features which are but imperfectly understood, the generally accepted physical description of the observed corona is less open to objection than Kellogg and Ney suppose This does not, however, rule out the possibility of an alternative explanation such as the one they propose We think it unfortunate that Kellogg and Ney have not compared the requirements of their theory with the most recent and reliable observations They seem not to appreciate the care that is now taken in eclipse work to avoid errors which are known to exist in earlier observations, and have adopted uncritically those earlier observations that they have considered In this communication we wish particularly to show that the agreement of the new theory with observation is not as good as its authors represent, rather than to criticize their theoretical reasoning

We have space to discuss only a few of the points made by Kellogg and Ney which seem to us especially open to objection For convenience these are taken in the order given in the original article

Scale height of the corona The model developed by Kellogg and Ney is suggested by the supposed similarity between the gradient of electron density in the corona (as calculated by these authors) and the gradient in the outer parts of the Van Allen belt The electron density in the solar corona has been the subject of many careful investigations, and in modern models of the corona it is supposed that, at angular distances of the order of $5R_{\odot}$ from the centre of the Sun, electron scattering contributes only about 15 per cent to the brightness However, for the purposes of their theory, Kellogg and Ney calculate the electron density assuming that *all* the light of the corona is due to electron scattering even out to $10R_{\odot}$ In their calculation they use a crude law ($1/R^6$) for the variation in brightness with distance from the Sun, an approximate method for conversion to electron densities, and then plot the results incorrectly in their diagram (According to their approximation, the electron density should vary with the linear distance $r_{\odot}$ from the Sun as r^{-5} the curve shown in their Fig 1 shows the variation as r^{-6}) Although we shall show later that we believe it wrong to neglect the contribution of the F corona out to $10R_{\odot}$, we assume for the present with Kellogg and Ney that this is permissible Baumbach's formula[2] for the brightness distribution fits the more modern observations (for example, those of Michard[3] and von Kluber[4]) within 10 per cent As Baumbach was not aware of the existence of the F component, we may also adopt Baumbach's electron densities, which assume a pure electron corona, and these are plotted in our Fig 1 together with the curve from Kellogg and Ney's diagram

Comparing the two, we see that at $10r_{\odot}$ from the Sun, and assuming electron scattering only, Kellogg and Ney have made a total error in electron density of a factor of ×350 The similarity between the Kellogg and Ney distribution and the Van Allen distribution is now almost entirely lost

In the latter half of their article Kellogg and Ney remark that there are at least three outstanding effects which are usually ignored in explaining the solar corona, these being the degree and direction of polarization, the infra-red excess, and the variation

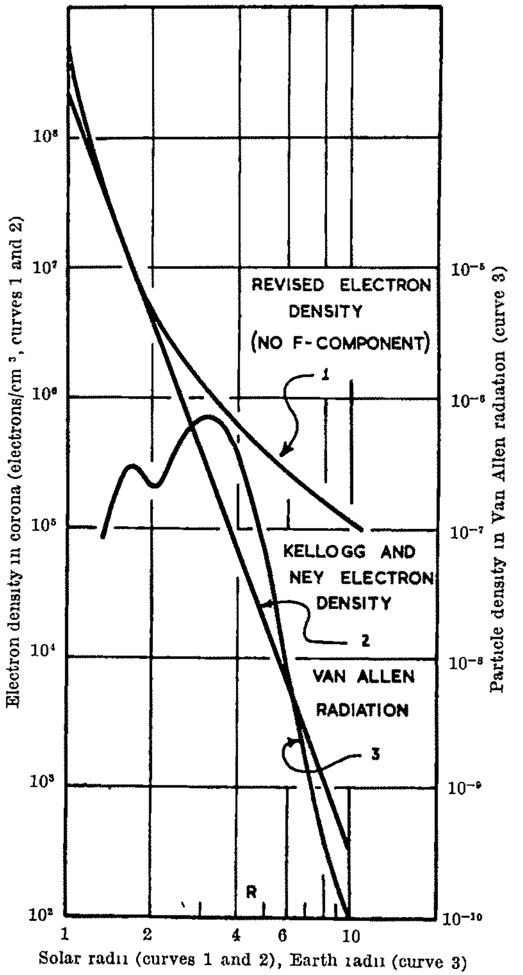

Fig 1 Plot of electron densities in the corona as calculated by Kellogg and Ney (curve 2) and revised by the present authors (curve 1) on the assumption of pure electron scattering, together with the particle densities in the Van Allen radiation (cf Fig 1 of ref 1)

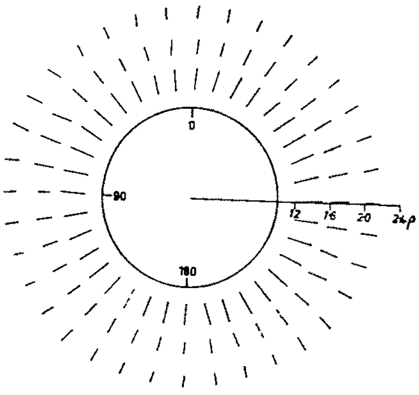

Fig 2 Direction of polarization (magnetic vector) of the coronal light observed by von Kluber at the 1952 eclipse (ref 4)

with phase in the sunspot cycle This statement is not correct, at least the first two of the effects mentioned are an important part of the conventional theory

Polarization of the coronal light Kellogg and Ney's second argument concerns the direction of the plane of polarization of the coronal light If the coronal light is merely sunlight which has been scattered by electrons or dust, or both, it must be partially polarized with the magnetic vector lying in a radial direction If, on the other hand, part at least of the light is synchrotron radiation, deviations from the radial direction would be expected which would depend upon the variation of strength and direction of the magnetic field along the line of sight As the authors remark, the measurement of direction of polarization is a very important one At the same time it is a very difficult one, and it is only in the last decade that the nature of the difficulties has been understood The sky background is strongly polarized, and except near the solar limb has an intensity comparable with that of the corona Most of the early observations of polarization were inadequately corrected for the sky background, even if the photometric procedures were adequate in the first instance, and should therefore be rejected The first author to correct for the polarization of the sky background was Öhman[5], who concluded from a careful analysis of his observations of the 1945 eclipse that the polarization of the corona at 5000 A was radial at all points examined Reliable measurements were also made by von Kluber[4] at a wave-length of 4300 A during the 1952 eclipse, his results are shown in Fig 2

Von Kluber considers that almost all deviations from the radial direction may be attributed to observational error

We now consider briefly the older observations quoted by Kellogg and Ney Zakharin's observations gave deviations of up to 80°, but Zakharin admits that the plates seem to be of very poor quality[6] Richtmeyer and Schmidt found an average deviation in three streamers of 9° and a maximum deviation of 17°, the original plates taken by Richtmeyer are of "moderate photometric quality" with irregular plate fog[7] Saito's results[8], not available to Kellogg and Ney, relate to the inner corona (there are only a few measurements beyond 6′), the deviations from radial polarization are all less than 15° and 80 per cent of the measured deviations are less than 7° It is worth commenting that the method usually used to determine the plane of polarization, namely, comparison of three simultaneous photographs, can easily lead to considerable error, especially in parts of the corona where there are large brightness gradients Summarizing, the best recent measurements do not support the large departures from radial polarization indicated by the two diagrams of Kellogg and Ney's paper

The degree of polarization is not considered by Kellogg and Ney For Thomson scattering the polarization can be computed once the distribution of electron density is known However, the computed electron density depends upon whether we assume that all the light is due to electron scattering, or whether part of it is due to either dust scattering or synchrotron radiation We therefore give in Fig 3 two curves showing the computed polarization of the electron component only Curve *A* is taken from von Kluber's work and is computed from the electron densities appropriate to a conventional model, curve *B* is taken from Baumbach's work and is computed assuming that all the light of the corona is due to electron scattering It is evident that the computed polarizations of the electron component do not depend critically on the form of the distribution of electron density Curve *C* shows the actual polarization observed by von Kluber in the equatorial regions The reasonable agreement in the region close to the Sun (1 $0R_{\odot}$–1 $5R_{\odot}$) supports the electron scattering theory Farther from the Sun the observed polarization becomes progressively smaller than that required for a pure electron scattering model, the explanation for this in terms of *F* and *K* components is that the part scattered by electrons is being diluted by an unpolarized component due to scattering by dust This seems a quite satisfactory explanation which is quantitatively supported by other evidence (for example, the observed equivalent widths of Fraunhofer lines) which we do not consider here

The infra-red excess of the corona The colour and infra-red excess of the corona have also been the

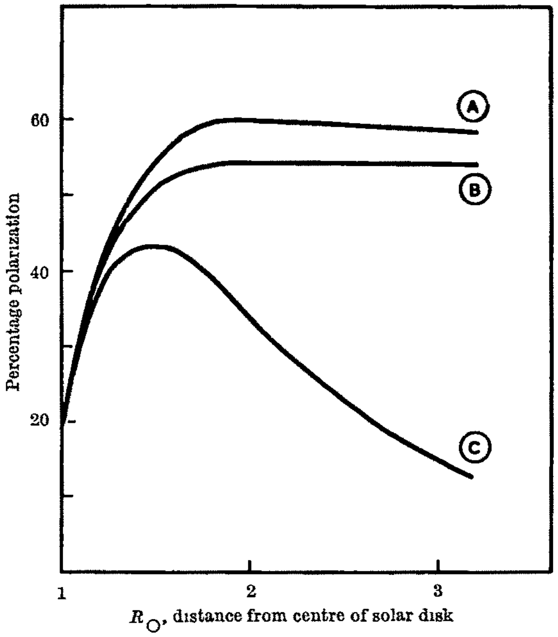

Fig 3 Observed and calculated polarizations of the solar corona, and their variation with distance from the solar limb Curve (*A*) polarization of *K* component only computed by von Kluber for his electron density distribution, (*B*) polarization computed by Baumbach, (*C*) actual polarization observed by von Kluber

subject of recent investigations Briefly, the results are that close to the Sun the colour is not significantly different from that of the average solar disk[9], but in the outer parts the infra-red excess becomes appreciable , at a distance of 2 5$R_\odot$ and at a wave-length of 1 9μ it has been measured to be 2 17 Such an excess is naturally explained by the diffraction theory of the *F* corona[10] That there is dust in the solar system is shown by the existence of the zodiacal light, and both van de Hulst[11] and Allen[12] have shown independently that both the *F* corona and the zodiacal light can be explained by a single model for the interplanetary dust The variation in infra-red excess mentioned by Kellogg and Ney is again accounted for by a varying ratio of electron component (with colour identical with that of the Sun) and dust component (which shows an infra-red excess)

We may remark here that after allowing for the dust corona in the conventional model the true electron densities in the outer solar atmosphere are considerably lower than indicated by the Baumbach curve in our Fig 1, and in fact are in rather better agreement with Kellogg and Ney's curve—but not for the reason these authors suggest However, at $10r_\odot$ there still remains a discrepancy of about ×40 between the true electron density and the lower value given by Kellogg and Ney

There is a contradiction here that is not satisfactorily explained by these authors in their article. If the conventional electron densities, or particularly Kellogg and Ney's densities, are accepted, the computed brightness at large distances from the Sun is much smaller than the observed brightness In conventional theory the extra light arises from dust scattering, but Kellogg and Ney attribute it to synchrotron radiation If this attribution is correct, synchrotron radiation must increase in importance with increasing distance from the Sun—and indeed we have shown that the infra-red excess increases in the outer corona But synchrotron radiation does not explain the existence of unbroadened Fraunhofer lines in these parts of the corona, although these lines are satisfactorily explained in terms of scattering by interplanetary dust particles far from the Sun

We shall not detail other criticisms which we feel could be made, but mention one last observational point Kellogg and Ney propose that if the solar corona is really analogous to the Van Allen particle belt, one might expect a maximum in the coronal intensity close to the Sun They believe that such a maximum might exist, supposing that "the problem of reversal in photographic emulsions has previously masked the possible presence of a maximum" So gross an effect as photographic reversal has not complicated the interpretation of eclipse photographs in any competent observations made since the 1890's There are in fact other much more subtle sources of error in the photometry of such a difficult object as the solar corona, and these errors may more readily be overlooked in photoelectric than in photographic photometry The most careful work in this region has never shown a maximum of the kind suggested by Kellogg and Ney, and its existence is very doubtful

We agree with Kellogg and Ney that further observations of the polarization over a greater range of wave-lengths are required and should be made at future eclipses Also, it is unfortunate that the most reliable measurements of polarization, and to some extent of infra-red excess, have been made near sunspot minimum , repetitions near maximum would be of value

However, we are of the opinion that the authors have not substantiated their claim that this interesting new theory accounts better for the observed properties of the corona While it may be that synchrotron radiation is a third contributor to the coronal light, we do not think the present observations support the postulate that sufficient synchrotron radiation exists to justify a major modification to the present two-component model of the corona

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We wish to express our appreciation for the critical comments made by Drs Blackwell and Dewhirst concerning our suggestions about the nature of the solar corona We are not professional astronomers and for this reason we may have placed undue emphasis on certain published literature, with perhaps too little emphasis on other literature more generally accepted by astronomers We do feel, in spite of the remarks of Drs Blackwell and Dewhirst, that under each of the topics which were discussed in our original article, experimental evidence exists which makes the possibility of synchrotron radiation from a magnetically contained corona at least a very plausible hypothesis

The principal objection of Drs Blackwell and Dewhirst seems to rest on a question of terminology To us, the *F* corona is not a real part of the corona, but represents a spurious effect which must be removed In the interests of brevity, we omitted any mention of the experimental difficulty of separating the *F*-coronal light from that of the electron corona, except for one or two comments, but we are aware of at least part of the evidence for the existence of the *F* corona Thus the curve which we marked curve 1 in our Fig 1 is supposed to represent the electron density and not the total coronal light It was plotted as $1/R^6$ not by mistake, as Blackwell and Dewhirst imply, but to represent the currently accepted electron densities Eclipses subsequent to the one observed by Turner have led to electron densities falling off as $1/R^6$ instead of $1/R^5$, as would have been obtained from the 1898 eclipse alone In order to obtain electron densities at large distances, the *F* corona must of course be removed Considering the rough nature of the ideas involved and the difficulties of measurement, we consider that the result is in reasonable agreement with our curve We pointed out the similarity of the solar corona and the radiation belt to indicate the attractiveness of confining charged particles by a magnetic field, in contrast to a gravitationally confined atmosphere. The comparison with the Van Allen radiation is intended only to be suggestive, and obviously no very close agreement is to be expected However, the most recent observation of the radiation belt by the Iowa group shows even better agreement with the coronal curve 1 than the results shown in curve 3 of our original article

It is unfortunately true that the measurements of Zakharin were made with some instrumental difficulties and the resulting plates were not of the highest quality. Nevertheless, these and the other measurements quoted by us remain the only measurements of the direction of polarization of the coronal light which were made near sunspot maximum It seems very likely that synchrotron radiation will be observed only near solar maximum Again, Nikonov's measurements of the infra-red excess were probably not as well done as the measurements by Blackwell in the 1952 eclipse Nevertheless, as they stand, they do not agree with the idea that the infra-red excess is due to the scattering by dust, since Nikonov observed that the infra-red excess was greatest at sunspot maximum when the electron density in the corona is greatest, and therefore the relative contribution of the F corona should be least So long as there are no more modern experiments to replace this Russian work, the answer to the questions which we are discussing must remain in doubt

In defence of our basic idea, we believe that Drs Blackwell and Dewhirst have taken too seriously the details of our suggestion but have tended to overlook or misunderstand the main features of a trapped corona Our concept is that magnetic fields anchored at the surface can act as guiding centres for particles which may then be confined between mirror points, as they are in fact in the Earth's magnetic field We accept as a working hypothesis that magnetic fields exist in the region of the solar corona We also believe, because of cosmic-ray evidence, that the Sun is able to inject high-energy particles into these magnetic fields If high-energy electrons are injected into magnetic fields, then synchrotron radiation will automatically occur In fact, if the corona were examined in light of long enough wave-length, the synchrotron radiation would necessarily be observable We wish to emphasize the point, which was made in our article, that the extent of the trapping of particles in the corona may depend strongly on solar activity, and therefore polarization and infra-red excess measurements made at sunspot minimum are definitely not evidence against our suggestions

Perhaps the title of our paper, "A New Theory of the Solar Corona", was too ambitious, since our model requires so many of the constituents of the description of the corona currently accepted The comments made by Drs Blackwell and Dewhirst seem to indicate that they believe we would reject the description of the corona in terms of K and F corona This is not correct; we certainly believe that the majority of the visible light from the inner corona is produced by Thomson scattering by slowly moving electrons, and it is almost impossible to escape the conclusion that the outer corona must be largely composed of dust grains, as has been very effectively discussed previously by Dr Blackwell We feel, however, that ultimately some experiment will reveal the existence of trapped particles, and that it is possible that this experiment may consist of measuring in redder and redder light the polarization of the corona at times of high solar activity Should the experiments in the visible or near infra-red reveal synchrotron radiation, our postulate of the magnetically trapped corona would be confirmed However, we do not believe that the absence of synchrotron radiation at visible wave-lengths would disprove our hypothesis Our calculations show that in order to see synchrotron radiation in the visible region of the spectrum, an integral energy spectrum for trapped particles would be required that goes at least as slowly with energy as $1/E$ An energy spectrum which falls as steeply as $1/E^2$ would not produce synchrotron radiation in the visible region in great enough intensity to be seen against the background of the Thomson scattered light

The reason for presenting our article in *Nature* was that a study of the literature to which we referred had in fact convinced us that enough doubt existed as to the coronal polarization to justify an intensive experimental study of the problem at sunspot maximum In the months that have followed since its submission, we have designed and constructed electronic telescopes which use photomultiplier detectors and television raster scanning to measure the polarization out to three solar radii in a pattern consisting of approximately 900 individual points The polarization will be measured in fixed positions in the corona and the scan will proceed from one position to the next until the entire area is covered This method eliminates many of the inherent difficulties involved in photometric measurements of coronal polarization The equipment which we have designed is to carry out the programme just described six times during the total eclipse of October 2, 1959, and we therefore hope that, cloud-cover permitting, we will be able to contribute some useful results on this rather important problem

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PROTON RESONANCE RELAXATION TIMES IN MOBILE LIQUIDS

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WE have measured the proton magnetic resonance relaxation times, T_1 at 250 ± 25 gauss and at 5,000 gauss and T_2 at 0 75 gauss, for a number of organic liquids and solutions at 25° C The results are summarized in Table 1

Although T_1 and T_2 have not been measured at the same field and so are not strictly comparable, the results suggest that T_2 may be appreciably shorter than T_1 The difference is most striking for the benzene solutions Some examples in which $T_1 = T_2$ have been observed, and also cases where more than one chemical type of proton is present have been studied[1,2]

Both T_1 and T_2 are strikingly shorter in fluorobenzene than in any of the other substituted benzenes The short T_2 is implicit in the results of Elliott and

Table 1 VALUES OF T_1 AND T_2 IN SEC FOR VARIOUS ORGANIC LIQUIDS AND SOLUTIONS AT VARIOUS FIELDS AND AT 25° C

Liquid	$T_2 \pm 10$ per cent at 0 75 gauss	$T_1 \pm 10$ per cent at 250 ± 25 gauss	$T_1 \pm 5$ per cent at 5,000 gauss	Literature values of T_1† (in sec)	at field (in gauss)	Literature values of T_2† (in sec)	at field (in gauss)
Water (H_2O)	2 7	3 6	3 6	3 4 (*a*)	2,000 and 7,000	2 7 (*d*) (temperature	7,000 not stated)
				3 5 (*b*)	1,650		
				3 4 (*g*)	7,000	3 0 (*e*)	0 5
*Cyclo*hexane (C_6H_{12})	3 5	5 5	7 1	6 5 (*b*)	1,650	—	—
Benzene (C_6H_6)	11	18	—	19 3 (*c*)	9,500	17 (*e*)	0 5
				19 0 (*b*)	1,650	10 (*d*)	7,000
Nitrobenzene ($C_6H_5NO_2$)	3 3	6 7	7 9	6 5 (*b*)	1,650	—	—
Chlorobenzene (C_6H_5Cl)	7 0	12 5	—	15 (*b*)	1,650	—	—
Bromobenzene (C_6H_5Br)	4 0	7 0	14 0		—	—	—
Fluorobenzene (C_6H_5F)	0 7 ± 0 2	0 7 ± 0 2	—	—	—	0 4 (*f*)	0 5
73 1 per cent C_6H_6* in CS_2	3 0	17 5	—	—	—	—	—
40 5 per cent C_6H_6 in CS_2	5 5	24		—	—	—	—
71 7 per cent C_6H_6 in CCl_4	6 0	16	—	—	—	-	—
42 0 per cent C_6H_6 in CCl_4	8 0	28	—	—	—	—	—

* Molecular

† Corrected to 25° C using viscosity if at slightly different temperature

References for literature values in Table 1 (*a*) = 17, (*b*) = 18, (*c*) = 4, (*d*) = 8, (*e*) = 7, (*f*) = 3, (*g*) = 19

Shumacher[3] at 0 55 gauss, although they do not claim to have measured a value of T_2

T_1 for the benzene solutions rises with dilution and would probably reach the value of $T_1 = 60$ sec observed by Nederbragt and Reilly[4] at 9,500 gauss for 8 per cent benzene in carbon disulphide measured by the recovery from saturation This emphasizes the anomalous nature of the T_2 values

The measurement of T_1 at any field-strength is straightforward Measurement of T_2 is much more difficult and values of T_2 in excess of about 1 sec require special care We have taken considerable pains to ensure a true measure of T_2, as has been briefly described[5], and which will be discussed in detail elsewhere[2]

For water a difference between T_1 and T_2 at 7,400 gauss has been reported[6] but the sample evidently contained dissolved oxygen and so the values are not strictly relevant The value of T_1 is well established and appears to be independent of the field A value of T_2 of 3 0 sec has been reported[7] and a value of 2 7 sec is implicit in the measurement of Meiboom and Gill[8] at 7,000 gauss Another result[9] appears to be T_2 in presence of a radio-frequency field

For benzene the value of T_1 of about 18 sec is well supported and is independent of the field A T_2 value of 16 ± 3 sec at 20° C and 0 5 gauss is reported from direct measurement of line-width[7] A reported value[10] of T_2 of 18 5 sec, at 2,000 gauss, was measured in the presence of the radio-frequency field, and theory[11,12] indicates that this T_2 should have the same numerical value as T_1, as observed We note an apparent dependence of the field of T_1 in bromobenzene and possibly in *cyclo*hexane

Although the difference of T_1 and T_2 is most striking for the longer relaxation times, it is more realistic to consider the quantity $(1/T_2) - (1/T_1)$ This is of order of magnitude 0 1 sec^{-1} If the relaxation times are shorter than about 1 sec, such a difference is difficult to observe[1]

Current theories of nuclear resonance relaxation[13,14,20] indicate $T_1 = T_2$ for these materials, since the molecular correlation time, τ_c, is of order 10^{-11} sec and the highest resonance frequency, ω_r, is of order 10^8 r/s so that $\omega_r\tau_c \ll 1$ A difference only arises for slow interactions, that is, $\omega_r\tau_c > 1$, and then it is usually very dependent on the field

The magnitude of the difference could be explained by the static interaction of any given proton with *one* other proton at about 300 A (about 50 molecular diameters), but since we have observed exponential decays, a substantial static interaction contribution is excluded This led us to consider the possibility that the difference could arise from interactions with distant protons which although weak, because of the factor r^{-6}, are numerous However, calculations in which the motional effects were allowed for, using the self-diffusion equation, showed that the effect is too small (We are grateful to Mr D P Rooke for assistance with these calculations) Most other known interactions make equal contributions to T_1 and T_2, for example, direct dipolar, anisotropic chemical shift, anisotropic indirect interaction and paramagnetic ions in low enough concentration The difference of T_1 and T_2 for water has been explained[6] in terms of the slow fluctuating field produced as a result of proton-exchange processes However, this effect should be proportional to the square of the field and it can scarcely explain benzene, *cyclo*hexane, etc The only moderately plausible general explanation we have found is that of a fluctuating isotropic indirect spin–spin (J type) interaction A constant J interaction does not cause line-splitting (except in fluorobenzene) because the protons are equivalent[15] However, if this coupling is explicitly dependent upon time, it becomes observable because the Gutowsky, McCall, Slichter[15] theorem is no longer valid It contributes to T_2 but not to T_1 A similar but not identical effect is found in liquid hydrogen fluoride[16] However, in order to produce $(1/T_2) - (1/T_1) \simeq 0$ 1 sec^{-1} with $J \simeq 10$ c/s, the coupling must be interrupted at about 10^5 times per sec This might be brought about by relatively infrequent 'violent' collisions between molecules Proton exchange is in this sense a violent collision The large effect in the benzene solutions would then be occasioned by the large electric fields produced by the polar solvent molecules However, interruption of J at this rate is unlikely, except in dissociating molecules, because J-type splitting of tens of cycles per second between inequivalent nuclei is observed in molecules in similar circumstances

Other experimental results on molecules containing more than one chemical type of proton will be discussed elsewhere[2]

The measurements of T_1 at 5,000 gauss were made by Mr A Hartland

Note added in proof A recent report[21] of measurements at 6,500 gauss shows precise agreement with our measurements for water but $T_1 \simeq T_2$ for benzene The explanation of the difference between T_1 and T_2 for water in terms of surface effects in the small sample seems scarcely applicable to our sample of 200 ml

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POSSIBLE MECHANISM OF CYSTEINE PROTECTION AGAINST RADIATION CATARACT

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EXPERIMENTS have shown that cysteine injected into an animal shortly before the eye is irradiated will largely prevent development of radiation cataract von Sallmann, Munoz and Barr[1] compared the histology of the lens epithelium in rabbits irradiated with or without a previous injection of cysteine and tentatively concluded that initial inhibition of mitosis by X-ray was unaffected, but that the number of nuclear fragments that developed after irradiation was smaller in the cysteine-treated lens von Sallmann *et al* used a dose of 1,500 r and it seemed possible that it might be easier to show histologically that cysteine affected radiation damage if the dose were nearer the threshold for mitotic inhibition We have therefore examined the effect of a pre-irradiation injection of cysteine on the mitotic inhibition, the subsequent mitotic overshoot and on the production of fragmented nuclei in the lens epithelium of rabbits using a dose of 500 r to the right eye The methods described by Pirie and Drance[2] were used Comparisons were made between litter mates and between right (irradiated) and left (not irradiated) lenses of the same rabbit These experiments have confirmed von Sallmann's earlier results The inhibition of mitosis is as great and even more prolonged after cysteine injection followed by X-irradiation than after X-irradiation alone The lens epithelium of the cysteine-treated rabbit shows no excess mitosis after inhibition has worn off In two experiments a dose of 300 r was given and again cysteine treatment did not prevent complete mitotic arrest at 24 hr Fig 1 shows that at all stages examined (2–28 days after X-ray) fewer fragmented nuclei were present in the lens epithelium of the cysteine-injected rabbit than in that of the animal irradiated without cysteine treatment

But we noticed that in the cysteine-injected rabbits the epithelium of the lens of the left, non-irradiated eye also showed an inhibition of mitosis This inhibition could be estimated through a comparison with the non-irradiated left eye of a litter mate not injected with cysteine In order to determine the degree and duration of this inhibition of cell division by cysteine a series of experiments was done in which one rabbit received an injection of cysteine and a litter mate was used as a control, no radiation being given to either Such pairs of rabbits were killed at intervals after the cysteine injection to one of the rabbits and comparisons made of epithelial

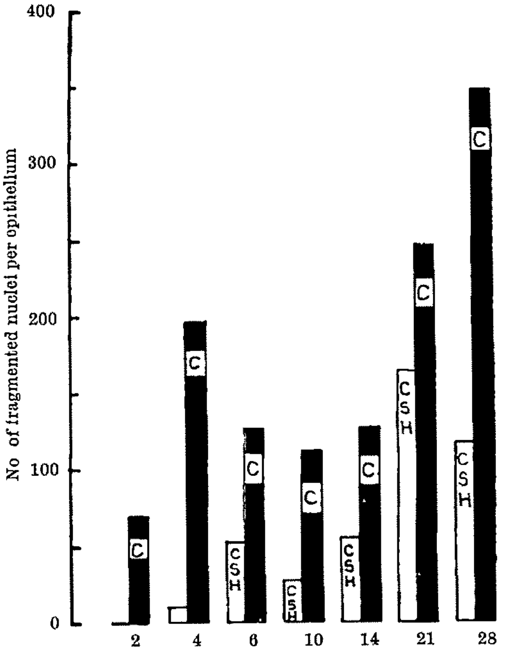


Fig 1 Effect of cysteine injection on the development of fragmented nuclei in the lens epithelium after X-irradiation

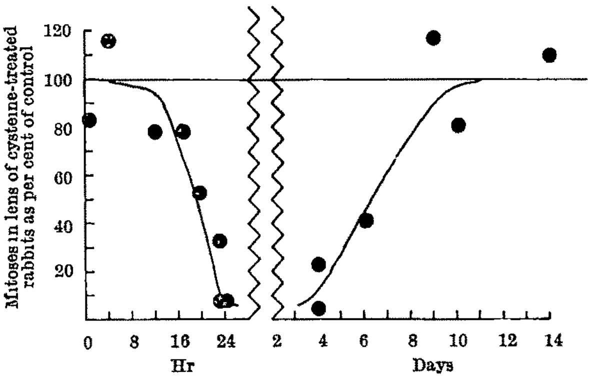


Fig 2 Effect of cysteine injection on mitosis in the lens epithelium

histology Fig 2 shows that cysteine injection arrests mitosis in the lens epithelium from 24 hr to 4 days This inhibition of cell division then gradually wears off without any subsequent excess of dividing cells or formation of fragmented nuclei or abnormal forms up to 28 days after cysteine injection

von Sallmann *et al* [1] had previously found in two rabbits that mitosis was normal 2 hr and 8 hr after injection of cysteine We examined lenses, 30 min , 4, 12 and 16 hr. after cysteine and found mitosis only slightly if at all depressed at these times The total number of dividing cells and the proportion in prophase and succeeding phases of mitosis were unchanged compared with the control lenses But at 20 hr mitosis was only 53 per cent of the control and at 23 hr it had fallen in one rabbit to 32 and in another to 8 per cent

1 gm /kgm is a very large dose of cysteine and was used only because this dose has been shown to prevent irradiation cataract For injection, cysteine hydrochloride was, in most experiments, neutralized with sodium hydroxide and injected, in a total volume of 5–8 ml , into the ear vein of the unanæsthetized rabbit It was noticed that the animals became almost immediately quiet, and in some cases their hind legs became inco-ordinated and they did not feed for some hours Controls injected with an equivalent amount of sodium chloride or 1 gm glycine per kgm did not show these signs, nor was there a fall in the mitoses of the lens epithelium In one experiment the cysteine hydrochloride was neutralized by shaking with 'Dowex-1'-bicarbonate resin, and the carbon dioxide blown off by passing nitrogen through the solution, thus avoiding the presence of sodium chloride in the solution to be injected The rabbits injected with this solution of cysteine showed the same signs of inco-ordination as those injected with cysteine neutralized with sodium hydroxide and the fall in mitosis in the lens epithelium was also apparent

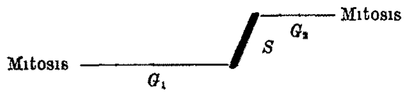
The question arises whether mitotic arrest by cysteine is related to its protective effect against X-ray damage to the lens von Sallmann, Dische, Ehrlich and Munoz[3] found that cysteine and cystine reached a maximum in the aqueous humour about 1 hr after intravenous injection After a dose of 2 gm cysteine to an adult rabbit a concentration of 40 mgm cysteine/100 ml aqueous humour (3 mM) was reached The concentration of cystine was about the same , both gradually declined over the next few hours Protection of the lens against radiation is effective 30 min after cysteine injection and, in spite of the fact that mitotic arrest cannot be demonstrated for at least 19 hr after cysteine injection, it seems reasonable to consider that the reaction(s) between cysteine or cystine and cell constituent(s) which leads to mitotic arrest must take place shortly after injection when cysteine and cystine are present in the aqueous humour von Sallmann *et al* [1] consider that mitosis in the lens epithelium may take only 30 min , but interphase must be prolonged, probably taking several days as in corneal epithelium (Friedenwald and Sigelman[4]) If cysteine interrupted some process early in interphase, all cells already past that point in the mitotic cycle could divide normally before any mitotic arrest became apparent This could explain the slow development of mitotic inhibition by cysteine

The effect of cysteine on synthesis of deoxyribonucleic acid was investigated in human bone marrow cells *in vitro* by measuring the incorporation of formate labelled with carbon-14 or thymidine labelled with tritium into deoxyribonucleic acid[5,6]

Cysteine, in a concentration of 1 mM, produced a 60–80 per cent depression of synthesis of deoxyribonucleic acid as indicated by grain counting on autoradiographs , a concentration of 0 1 mM also produced a significant depression, ranging from 30 to 50 per cent

The concentration used in the rabbits was 1 gm / kgm , which corresponds to a concentration of about 10 mM in the whole animal, the concentration in the aqueous humour being of the order of 1 mM (von Sallmann *et al* [3])

The following is a scheme of the intermitotic cycle where S is the period of synthesis of deoxyribonucleic acid, G_1 and G_2 are pre- and post-synthetic gaps respectively



If synthesis of deoxyribonucleic acid is reversibly depressed in a cell, the onset of mitosis will be delayed If the G_2 period is not affected then the delay in mitosis will appear only after a certain period, that is, cells already in G_2 period can proceed normally and enter mitosis, but the 'feed' of cells into the G_2 period will be depressed if the S period is elongated The findings on mitotic counts in lens epithelium indicate that this, in fact, may be the case the depression in mitosis by cysteine is observed only after a certain period (presumably corresponding to the length of G_2 period in these cells)

It is not known at this stage whether processes in the G_1 period are affected by cysteine or not It is unlikely, however, that such concentrations of cysteine would affect synthesis of deoxyribonucleic acid only—nuclear phosphorylation is known to be affected by large doses of cysteine (Stocken and Creasey, personal communication), and Mazia[7] has shown that mercaptoethanol will inhibit division of the fertilized egg of the sand dollar , he suggests this is due to a reaction between mercaptoethanol and the protein which forms the mitotic spindle He considers that formation of the fibrous spindle requires S—S links between protein molecules and that mercaptoethanol prevents their formation by competing with the available SS or SH groups

If the process in interphase which is interrupted by cysteine lies earlier than the process which is radiosensitive, then so long as arrest by cysteine is reversible, one can postulate that cysteine protection is related to its ability to arrest mitosis Such protection can never be complete, as some cells will be in a stage of the mitotic cycle that is insensitive to cysteine but is radiosensitive Cysteine protection against radiation cataract has in fact never been found to be complete

$$\text{division} \rightarrow \underbrace{a \rightarrow b \overset{\text{cysteine}}{-\!\|\!\!\rightarrow} c \rightarrow d \overset{\text{radiation}}{-\!\|\!\!\rightarrow} e \rightarrow f}_{\substack{\text{interphase} \\ \text{(several days)}}} \rightarrow \underbrace{\text{prophase} \rightarrow \text{division}}_{\substack{\text{mitosis} \\ \text{(30 min)}}}$$

The above scheme suggests a possible mechanism, but there is no evidence that this is a correct hypothesis, and the possibility of enhanced recovery phenomena in cysteine-treated cells should also be borne in mind At present there is only the observation that cysteine arrests cell division in the lens epithelium of the rabbit and that if given before irradiation the number of fragmented nuclei that develop afterwards is reduced Previous work has shown that cysteine largely protects from X-ray cataract

Thanks are due to the Medical Research Council and to the National Council to Combat Blindness Inc , New York, for expenses grants, and to Mrs M Overall for skilled technical assistance

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RELEASE OF ADENOSINE TRIPHOSPHATE AND SEROTONIN FROM INJURED CELLULAR BLOOD ELEMENTS IN EXTRACORPOREAL CIRCUITS

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CORPUSCULAR blood trauma, especially red cell and platelet damage, is still a problem inherent to extracorporeal circulatory systems, including the heart–lung machines[1,2] Hæmolysed blood has been reported to possess vasodilator properties attributed to the release of adenosine triphosphate and/or closely related compounds from injured red cells[3] Platelets, in turn, are known to contain large amounts of 5-hydroxytryptamine (serotonin)[4], a biogenic amine with powerful vasoactive, bronchomotor and other effects[5] In consequence, the question arose whether these humorally acting agents would be released into plasma in extracorporeal blood circuits and whether the resultant humoral pathological blood changes would serve as a guide for disentangling the mechanisms of some complications associated with the use of heart–lung machines for open cardiac surgery

As a tentative approach to the problem an arteriovenous (femoral artery–superficial jugular vein) shunt, consisting of a polythene tube 1 m long, was created in four dogs and five rabbits pretreated with subcutaneous pethidine hydrochloride (2 mgm /kgm) and anæsthetized with intravenous sodium pentobarbitone (30 mgm /kgm) To mimic the blood trauma in the current heart–lung machines with greater surface area, pumps and filters, the inner surface of the shunts was intentionally 'cleaned' with steel-wool Just prior to opening of the shunt the animals were heparinized (5 mgm /kgm) In the period of extracorporeal circulation via the shunt the corpuscular blood changes and the whole blood- and plasma-levels of adenosine triphosphate and 5-hydroxytryptamine were observed For that purpose three blood samples of about 4 ml were taken with a siliconized syringe needle from a rubber tube incorporated to the shunts The first blood sample was taken immediately after opening of the shunt and the subsequent samples 30 and 90 min later The corpuscular blood changes were determined by using routine techniques The whole blood- and plasma-levels of adenosine triphosphate were determined by the colorimetric micromethod of Rehell *et al* [6] The 5-hydroxytryptamine content of whole blood and plasma was, after overnight extraction in cold acetone (4° C), assayed by the method of Erspamer[7] based on the contraction of œstrous virgin rat uterus The urinary excretion of this substance and 5-hydroxyindoleacetic acid (the main excretory product of 5-hydroxytryptamine) was studied in dogs only The urinary bladder was catheterized immediately after induction of anæsthesia Then the urine excreted before (45 or 90 min) and during (90 min) extracorporeal circulation was collected, measured for volume and analysed for 5-hydroxytryptamine and 5-hydroxyindoleacetic acid The former was assayed by the same technique as that in blood and plasma, the latter according to the spectrophotometric method described by Udenfriend and associates[8]

No major alterations were found in the whole-blood adenosine triphosphate during extracorporeal circulation This was particularly true for dogs, while in rabbits some decrease in the whole-blood adenosine triphosphate became evident The erythrocyte count and the hæmatocrit values, correspondingly, remained substantially unaltered in dogs, while in rabbits there was some decrease in the erythrocyte count and hæmatocrit values At the start of extracorporeal circulation no adenosine triphosphate was detected in the plasma of either rabbits or dogs In both rabbits and dogs, however, increasing amounts of adenosine triphosphate appeared in the plasma during extracorporeal circulation, the rising trend being more pronounced in rabbits than in dogs (as terminal phosphate-P., from zero to an average of 0.9 mgm./100 ml. and from zero to an average of 0.35 mgm./100 ml., respectively). We had the impression that the degree of hæmolysis, estimated visually from the colour of the plasma in the successive samples, paralleled the changes in the adenosine triphosphate of the plasma; with increasing hæmolysis more adenosine triphosphate was detected in the plasma. The whole-blood 5-hydroxytryptamine generally showed a clear-cut trend to decrease during extracorporeal circulation in both rabbits and dogs. Concomitantly the platelet counts fell, while the plasma 5-hydroxytryptamine levels were increased. Again, the drop in the platelet count was more pronounced in rabbits than in dogs (on the average from 318,000 to 71,000/cu.mm. and from 329,000 to 249,000/cu.mm., respectively). The same held for the fall in the total white cell count observed in both rabbits and dogs. In contrast to the plasma adenosine triphosphate, considerable activity of 5-hydroxytryptamine was found in the plasma at the start of extracorporeal circulation (average 0.2 μgm./ml. in rabbits and 0.025 μgm./ml. in dogs). In rabbits the levels of plasma then steadily increased during extracorporeal circulation (up to an average of 0.38 μgm./ml.). In dogs the plasma 5-hydroxytryptamine increased in the early period of extracorporeal circulation (on the average from 0.025 μgm./ml. to 0.045 μgm./ml.), but towards the end of extracorporeal circulation 5-hydroxytryptamine of the plasma showed some tendency to fall. The urinary excretion of 5-hydroxytryptamine in dogs prior to extracorporeal circulation averaged 0.002 μgm./min. In two of the four dogs there was actually no activity of 5-hydroxytryptamine in the urine before extracorporeal circulation. In the urine collected during the period of this circulation the activity of 5-hydroxytryptamine was consistently increased; the urinary excretion of 5-hydroxytryptamine attained an average level of 0.005 μgm./min. Reverse changes were noted in the urinary excretion of 5-hydroxyindoleacetic acid; this fell from an average of 0.78 μgm./min. before extracorporeal circulation to an average of 0.38 μgm./min. during this circulation.

Adenosine compounds are presumably liberated from all injured tissues. Platelets, for example, are rich not only in 5-hydroxytryptamine but also contain appreciable amounts of adenosine triphosphate[9]. However, proceeding from the knowledge that red cells are particularly rich in adenosine compounds, including the phosphate[3,6], that they are susceptible to mechanical trauma[3] and that their total mass in the circulatory system is enormously greater than that of the other cellular blood constituents, it is obvious that the red cells were the main source of the adenosine triphosphate released into the plasma in the present experiments. According to Udenfriend and Weissbach[4], platelets contain all the 5-hydroxytryptamine present in the whole-blood, while none is found in the plasma. Yet we found considerable activity of 5-hydroxytryptamine in the plasma already at the start of extracorporeal circulation. This may be explained by the fact that after short centrifugation at low running rates, as used to avoid hæmolysis in the present experiments (for 10 min. at 2,000 r.p.m.), the plasma still contains platelets[10]. Nevertheless, the gradually increasing levels of plasma 5-hydroxytryptamine during extracorporeal circulation, with an associated fall in the platelet counts, indicate that 5-hydroxytryptamine was steadily liberated from disintegrated platelets. The consistently increased urinary excretion of 5-hydroxytryptamine during extracorporeal circulation further indicates that 5-hydroxytryptamine was actually released into the plasma in the period of this circulation, for increased urinary excretion of 5-hydroxytryptamine has been observed after administration of exogenous 5-hydroxytryptamine[11]. Finally, the definitely higher levels of whole-blood (and plasma) 5-hydroxytryptamine in our rabbits as compared with those in dogs, the platelet counts being equal, are in agreement with the figures for 5-hydroxytryptamine content of platelets in these species[4].

The blood trauma in the present experiments was of the same general degree as that in the current heart–lung machines. On the other hand, exogenous adenosine triphosphate and 5-hydroxytryptamine at minute dose-levels have been reported to elicit vasodilatation and systemic hypotension[3,5,12]. Intense bronchoconstriction[5], pulmonary vasoconstriction[5] and potentiation of the action of hypnotics (barbiturates)[13] are further reactions to exogenous 5-hydroxytryptamine. With these facts in mind it seems possible that the complications associated with the use of heart–lung machines for open cardiac surgery, such as hypotension, cyanosis and a delay in the recovery from anæsthesia with eventual death[2], might be largely effected by such physiologically highly active agents as adenosine triphosphate and 5-hydroxytryptamine liberated into plasma from injured cellular blood constituents. Significantly enough, even in the present experiments deepening of the anæsthetic-level during extracorporeal circulation, as well as a delay in the recovery from anæsthesia, were repeatedly observed. In addition, 5-hydroxytryptamine has been found to be about one hundred times as effective as histamine in raising capillary permeability and in producing œdema[14]. Taken together with the above results, it also seems possible that such unexplained features as the œdematous changes in perfusion preparations of different types and more particularly the myocardial œdema, continuously increasing coronary flow and "Spontaninsuffizienz" known to occur in the heart–lung preparations[15] would be causally related to the humoral pathological blood changes under consideration. The present results are being described and discussed in detail elsewhere[16].

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AMPLITUDE-MODULATION RADIO-TELEMETRY OF NERVE ACTION POTENTIALS

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INFORMATION concerning the functioning of intact animals has been successfully telemetred to remote points from satellites, missiles, large centrifuges and other situations[1]. The present report describes experiments in which the response of a single type of excitable tissue (nerve trunk or fibre) was relayed to and recorded at a distant point by telemetry. The basic problem is one of transmitting a pulse to the preparation at a distant point, and receiving the response to this stimulus at the point of transmission.

This series of experiments passed through several phases which will be described in another communication[2]. The system made use of two radio links, one for each direction in which information was to flow, and was set up in one building. The required stimulating pulse was produced by a Grass *S4-C* stimulator and used to amplitude-modulate a Hallicrafters *S-27RS* radio transmitter by means of the Model 115 amplitude-modulator of Measurements Laboratory (Boonton, New Jersey). The modulator operated at a minimum external modulating frequency of 30 cycles, provided up to 100 per cent modulation with low envelope distortion, allowed accurate metered per cent modulation calibration, and produced amplitude modulation of the stimulus intelligence with negligible accompanying incidental frequency modulation, thus allowing narrow-band receiver operation. In accordance with amplitude modulation theory, the stimulus, or modulating voltage, was introduced in the plate voltage supply line and added to the plate supply voltage at a rate and magnitude determined by the modulating signal and the modulator output. In this type of system, developed by Hartley, the carrier signal originates in a crystal-controlled oscillator, is raised to full power by amplifiers, and is modulated in the final stage of power amplification which operates Class *C*. Since the load is fixed, as the voltage level changes because of the modulation, the tank voltage swing, the plate current operating angle, and the current-pulse form and amplitude change so that the d.c. plate voltage varies linearly with respect to the square root of the power output. This permits distortionless amplitude modulation, but the modulator must supply power equal to one-half of the unmodulated carrier power at 100 per cent modulation.

The radio-frequency carrier can be expressed as $y = A(t) \cos \gamma(t)$ and in amplitude modulation the signal intelligence (nerve stimulus and response) is made to control the amplitude parameter of the carrier by the relation

$$\begin{aligned} A(t) &= [A0 + af(t)] \\ &= [A0\{1 + maf(t)\}] \end{aligned}$$

The scheme for the plate-operated output stage and a block diagram of the entire system will be found in Fig. 1. A complete mathematical analysis of the carrier and amplitude spectra may be found elsewhere[3].

The antenna used to recover the signal at a distant point was a vertically mounted dipole designed for optimum reception of the tuned frequency (72.25 Mc./s.), fed into a coaxial transmission cable. The intelligence present in the amplitude-modulated wave was recovered by impressing the modulated

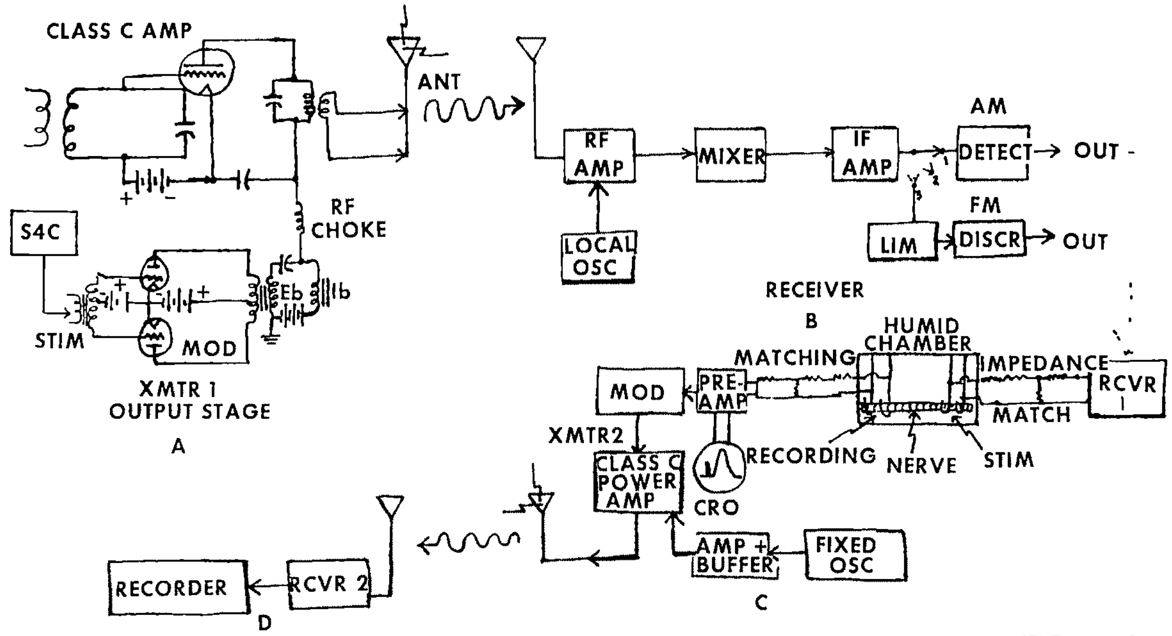

Fig. 1 (A). Plate-modulated output stage. Explanation in text. Transmitter I relays stimulus signal to receiver I. (*B*) Receiver I demodulates signal intelligence and (*C*) impresses stimulus on to stimulating electrodes via impedance network. Pick-up electrodes feed response through matching network to transmitter II, then relay response (also monitored on CRO) back to (*D*) receiver II, where it is demodulated, amplified and drives pen-recorder

wave on a non-linear network which, for low-strength signals, employed a voltage-current characteristic represented by the following terms of a Taylor series

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$$i = I_b + G_1 e + G_2 e^2 \qquad (1)$$

where the predominant term is G_2e^2 The carrier and first side-frequency pair which result from the amplitude-modulation of the carrier $E_0\sin\omega_0 t$ by the modulating wave $ME_0\cos\omega_1 t$ were impressed at the input of this network The impressed voltage, containing the stimulus intelligence, can then be written

$$e = E_0\sin\omega_0 t + \frac{ME}{2^0}\{\sin(\omega_0 + \omega_1)t + \sin(\omega_0 - \omega_1)t\} \qquad (2)$$

It is found by combination and substitution that the square-law term yields a series of waves The wave corresponding to the original intelligence is $G_2ME^{2\cos\omega_1 t}$ Its amplitude is proportional to the square of the voltage This wave was then amplified and fed through a network which matched the output impedance of the receiver to the bipolar stimulating electrodes. In operation, the receiver's *S*-meter was used as a carrier-level indicator for amplitude modulation, and the best records were obtained with the receiver tuned slightly to one side of the carrier frequency A Ferris model 18-*B* signal generator was used to align the receiver, which was also a Hallicrafters model *S*-27*RS* In later experiments employing frequency modulation a separate stage of the receiver assembly, known as the 'frequency unit', rectified the alternating current output of the receiver, and the d c output of the frequency unit was fed to a visual meter and recorder

The response of the preparation was picked up by silver–silver chloride electrodes, and after source-impedance matching and amplification, modulated another radio transmitter which transmitted the information back to the originating point Here, after demodulation and amplification, the pulses were used to activate a strip-chart recorder (Leeds and Northrup Speedomax Type *G* Model *S* 60000 series) Sciatic nerves of bullfrogs (*Rana catesbiana*) and radial or ulnar nerves of dogs (*Canis canis*) were used A total of 11 nerves was tested Single motor fibres were used in some experiments, which closely followed the bridge-insulator technique of Tasaki[4] Details of those studies will be included in ref 2 With the distal end crushed, whole nerves were placed on two pairs of electrodes in a humid chamber at 20° C The location of the active pick-up electrode was 7 5 cm distal to the stimulating cathode and 1 2 cm proximal to the inactive pick-up electrode The distal electrode was connected to earth and the proximal one was anode during the pulse The monophasic action potential was monitored at the site of the preparation by d c amplification and display on an oscilloscope The stimulating pulse, measured at the output of the distant receiver, was 0 1–0 5 msec in duration, and its amplitude was adjusted to be supramaximal for beta fibres

The duration of the responses was 1–3 msec and the maximum amplitude about 30 mV The wave form of the action-potential was not recorded, but simply the fact of its having occurred The portion of the record in Fig 2 shows the responses of the inkwriter to slow stimulation rates, and shows also that the write-out is proportional to amplitude Thresholds as determined by the onset of activity of the inkwriter varied from 14 to 15 mV , and did not differ significantly for amphibian as compared with mammalian nerve

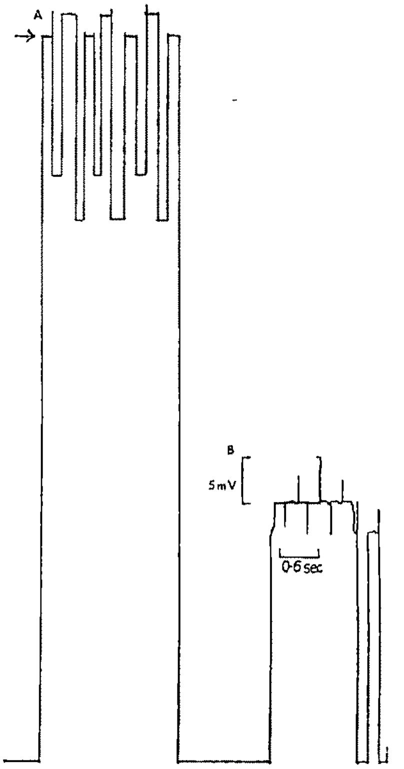

Fig 2 Photograph of segment of ink write-out showing (*A*) threshold of 15 mV (at arrow) for a single nerve

Conduction velocity was determined by the spacing between the rectangular pulse outlines on the record and ranged in all nerves from 23 5 to 36 8 m /sec In some experiments reproducible records were easily obtained for 15–20 hr , during part of which the whole system could be left unattended except for changing the paper or filling the ink-reservoir of the recorder For auditory monitoring during such periods a loudspeaker was connected to the 5,000-ohm terminals of receiver II

The special problem encountered in this application of telemetry is the matching of receiver output and input impedance-levels to bipolar stimulating and recording electrodes and the matching of the transmitter modulator inputs to the output of the stimulated nerve, with the assumption that the resting resistance is about 20 k -ohms max and that the resistance during activity is no more than 10 per cent of that value

Theoretically it is possible for the nerve to be stimulated by the carrier wave itself In general, for carrier frequencies at which losses in the preparation are not too great, the shape of the carrier envelope for the directly applied carrier would be expected to have the same shape as that obtained with a d c pulse Since the response is transmitted over a radio link it is more convenient to use the d c pulse for stimulation

The electrical process of the nerve impulse is a signal similar to those encountered in data-handling telemetry systems used for aircraft and missile testing and for satellite experiments It is now possible to determine the effect on the whole nerve or single fibre (if properly packaged) of magnetic, gravitational or radiation fields at very high altitudes, in vehicles undergoing changes in acceleration The long periods of time during which the output of the nerve is relatively constant when stimulated remotely by a constant stimulus assure adequate data for statistical analysis The method therefore allows measurement of changes in angular acceleration, both positive and negative Basic physiological data which can be collected in such circumstances include threshold, rheobase, chronaxie, strength-duration and strength-latency curves, refractory periods and critical stimulus interval for 2 stimuli Controlled variation in potentials led from electrodes implanted in animal brains can also be studied by this means, either on the ground or in guided or orbital flight By using a frequency modulated/frequency modulated multichannel system of the type commonly employed in satellite research, the wave-form of the action potentials can be recovered with fidelity through high-frequency interrogation during the passage of impulses Its relationship to environmental variables can then be determined With interval-measuring equipment at present available, nerves might be used in orbital vehicles as biological clocks to determine directly whether or not there is a relativistic shift for excitable tissue[5] This cannot be done at present with intact animals or astronauts

I wish to thank Messrs W Boynton, R Bottom, and A Fisher of the United States Weather Bureau for valuable advice concerning the operation of the transceiver units Mr P Baby of Electromechanical Research, Inc , furnished helpful references

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COMPOSITION OF A PARAFFIN WAX FRACTION FROM TOBACCO LEAF AND TOBACCO SMOKE

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THE paraffin wax of tobacco leaf and smoke is generally regarded as a mixture of *n*-paraffinic hydrocarbons, with *n*-hentriacontane as the major component[1-3] The isolation of pure paraffinic hydrocarbons from both leaf and smoke has been claimed in a number of instances[4,5], but it is open to question whether the specimens were, in fact, homogeneous, for in every case the melting point was the only criterion of purity employed and it has been shown that melting points alone do not afford a reliable guide to the purity of paraffinic hydrocarbons[6]

We have obtained additional evidence of the complex nature of the wax through mass spectroscopic and gas-liquid chromatographic analyses of fractions obtained from green tobacco leaf (*Nicotiana tabacum*, Delcrest variety), from the 'black' fermented tobacco of a variety of Argentinian cigarettes and from the smoke of these cigarettes The analyses were very kindly carried out for us at Thornton Research Centre, 'Shell' Research, Ltd , through the generosity of Dr R Graham, and the results, shown in Tables 1 and 2, indicate clearly that the wax from each of the three sources is a mixture of broadly similar composition *n*-Hentriacontane is the main individual component, but appreciable quantities of the neighbouring odd-numbered homologues and small amounts of the even-numbered homologues are present as well Dr Graham has informed us that the precision of the mass-spectroscopic analysis is not high, and no significance should thus be attached to the apparent small differences in composition of the three waxes An interesting and novel feature of the results is the high proportion of *iso*-alkanes disclosed by mass spectroscopy So far as we are aware, *iso*-alkanes have not previously been detected in the paraffin wax of tobacco or indeed of other plants, although their presence in cigarette smoke has been noted[3] (Since writing this article, we have seen a publication by Mme Suzanne Barbezat (*J Recherches du Centre National de la Recherche Scientifique*, 45, 273 , 1958) in which it is reported that the paraffins of tobacco and tobacco smoke, though predominantly normal, may contain branched chain isomers Dr A I Kosak has also informed us that he and Dr J S Swinehart have detected branched chain isomers in the paraffin fraction of cigarette smoke We are

Table 1 MASS SPECTROSCOPIC ANALYSIS OF PARAFFIN WAXES

Carbon No	Source of wax								
	Green leaf			Fermented tobacco			Cigarette smoke		
	n-Alkanes	*i*-Alkanes	Total	*n*-Alkanes	*i*-Alkanes	Total	*n*-Alkanes	*i*-Alkanes	Total
25	0 9	0	0 9	0 7	0	0 7	0	0	0
26	0 6	0	0 6	1 2	0	1 2	0 5	0	0 5
27	3 0	0 9	3 9	5 9	0 8	6 7	5 2	0 8	6 0
28	0 1	0	0 1	0 9	0	0 9	0 5	0	0 5
29	6 6	15 9	22 5	6 3	11 0	17 3	5 2	15 3	20 5
30	0 9	2 5	3 4	0 6	1 6	2 2	1 0	1 5	2 5
31	24 1	24 4	48 5	26 6	20 4	47 0	25 7	20 2	45 9
32	3 9	2 4	6 3	5 1	2 0	7 1	4 3	1 9	6 2
33	10 8	3 3	14 1	13 1	3 9	17 0	14 3	3 5	17 8
Total	50 9	49 4	100 3	60 4	39 7	100 1	56 7	43 2	99 9

The *n*-alkane/*i*-alkane ratio is based on an accepted sensitivity ratio of 1/10

Table 2 GAS-LIQUID CHROMATOGRAPHIC ANALYSIS OF PARAFFIN WAXES

	Green leaf wax	Fermented tobacco wax	Cigarette smoke wax
Percentage area $n-C_{24}$	—	—	0 1
,, ,, $n-C_{25}$	0 5	—	0 6
,, ,, $n-C_{26}$	0 3	0 3	0 4
,, , $n-C_{27}$	7 5	4 4	6 3
,, ,, $n-C_{28}$	0 6	1 0	1 1
,, ,, $n-C_{29}$	8 8*	9 2*	7 4
,, ,, $n-C_{30}$	3 9†	7 1	3 8†
,, ,, $n-C_{31}$	47 0*	46 5*	43 4*
,, ,, $n-C_{32}$	12 5	16 0	13 0
,, ,, $n-C_{33}$	18 9*	15 5*	22 8*
,, ,, $n-C_{34}$	—	—	1 1

Column 3 ft , silicone grease *E* 301 on 52–85 mesh 'Silocel' at 288° C , nitrogen flow-rate, 1 6 l /hr

* These peaks were composed of two unresolved peaks The results given include both peaks The impurity is probably a very slightly branched paraffin

† These peaks were probably due to $n-C_{30}$ paraffins but this was not fully confirmed

indebted to these authors for telling us of this result before publication) The Thornton workers have interpreted the present results as due to the presence of 2-methylalkanes

For the preparation of the materials for analysis, neutral extracts of the tobacco and a neutral fraction of the cigarette smoke condensate were chromatographed on alumina and the initial waxy fractions eluted with light petroleum (b p 40–60° C) were treated with urea in warm methanol[7] The resulting adducts were washed with light petroleum, decomposed with water, and the recovered paraffins crystallized once from benzene-ethanol The melting points and elementary analyses are shown in Table 3 The waxes showed no light absorption in the ultra-violet, indicating the absence of unsaturated compounds, and their infra-red spectra determined on a Perkin–Elmer 'Infracord' spectrometer were very similar to that recorded for *n*-triacontane[9] The method of isolation does not rule out the presence of *iso*-paraffins, for it is known that slightly branched paraffins will form urea adducts if the main chain is long enough[8] Attempts to obtain additional evidence for the presence of *iso*-alkanes by high resolution infra-red spectroscopy in the 1,500–1,300 cm^{-1} region were inconclusive in the absence of suitable reference compounds

Table 3

Source of wax	Green leaf	Fermented tobacco	Cigarette smoke
Melting point	60–63° C	60–63° C	61–64° C
Elementary analyses	C, 85 4 H, 14 5	C, 85 4 H, 14 3	C, 85 4 H, 14 5

Little consideration appears to have been given to the possibility that the considerable amounts of paraffin wax in cigarette smoke may play some part in its carcinogenic activity[10] In this connexion, attention might be directed to the report by Horton, Denman and Trosset[11] that the production of tumours on mouse skin by 3 4-benzpyrene and by 20-methylcholanthrene was considerably accelerated and the tumour incidence increased when the carcinogens were applied in conjunction with a large excess of certain high molecular weight hydrocarbons, including some *n*-paraffinic hydrocarbons It is not inconceivable that a similar combined action of the paraffins and the carcinogenic aromatic hydrocarbons[12] in cigarette smoke may contribute to the carcinogenic activity towards mouse skin of the smoke, and may account, in some measure, for the fact that the smoke is more potent than might be expected from its very small content of aromatic hydrocarbon carcinogens[13]

In other experiments we have prepared the methyl esters of acids obtained from the flue-cured tobacco of a variety of British cigarettes, and a fraction of the esters b p 190–210°/0 5 mm has also been analysed by mass spectroscopy and gas-liquid chromatography at the Thornton Research Centre To obtain the esters the tobacco was extracted with chloroform, and the alkali-soluble fraction treated briefly with ethereal diazomethane The mass spectroscopic results (Table 4) show that methyl palmitate is the major component of the mixture, accompanied by some stearate and smaller amounts of a number of other higher and lower homologues A considerable amount of C_{18} unsaturated esters is also present, with methyl linolenate predominating An essentially similar result was obtained in the gas-liquid chromatographic analysis Most of the acids corresponding to these esters have already been found in cigarette smoke, in which palmitic acid and C_{18} unsaturated acids appear to be particularly abundant[2,5] Palmitic acid was also found to be the principal fatty acid of an American bright green leaf by Hellier[14], and it is of interest that the palmitate and linolenate were the main components of a mixture of solanesyl esters recently isolated from an American flue-cured leaf[15] A mixture said to contain methyl laurate, myristate and palmitate has also been obtained from a Japanese flue-cured tobacco[16]

Table 4 MASS SPECTROSCOPIC ANALYSIS OF TOBACCO METHYL ESTERS*

Ester	Acid carbon No	Ester molecular weight	Peak height	Relative sensitivity	Relative quantity
Caprate	10	186	6	0 20	30
	11	200	4		
Laurate	12	214	3	0 42	7
	13	228	0		
Myristate	14	242	7	0 63	11
	15	256	6		
Palmitate	16	270	297	0 80	352
Margarate	17	284	25		
	18†	288	12		
Arachidonate	18†	290	31		
Linolenate	18†	292	115		
Linoleate	18†	294	73		
Oleate	18†	296	13		
Stearate	18	298	70	1 00	70
Nonadecylate	19	312	7		
Arachidate	20	326	19		
	21	340	4		
Behenate	22	354	11		
	23	368	4		
	24	382	4?		
	26	410	3?		

* Because of lack of knowledge of the relative sensitivities of many of the compounds the results can only be reported incompletely

† Unsaturated

We are very greatly indebted to Dr Robert Graham and the mass-spectroscopic and gas-liquid chromatographic research groups of Thornton Research Centre, 'Shell' Research, Ltd , for the mass spectroscopic and gas-liquid chromatographic analyses We thank, also, Mr Ivan Neas, director of the Tobacco Research Board of Rhodesia and Nyasaland, for supplying the green tobacco leaf, Dr J R Plimmer for the crude wax fraction of the green leaf, and Dr J W Cook for his interest in the investigation

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HÆMOGLOBIN *P* IN A FAMILY IN THE BELGIAN CONGO

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A SURVEY of abnormal hæmoglobins has been carried out on 1,000 African pregnant women visiting the Outpatients Department of the Government Hospital at Stanleyville. The results will be published in detail elsewhere, but it is of interest here that on two occasions hæmoglobin *P* was discovered. Hæmoglobin *P* was first described by Schneider and Haggard[1]. On paper and open boundary electrophoresis at alkaline *p*H, hæmoglobin *P* moves more slowly to the positive pole than hæmoglobin *A* and separates from that pigment. It moves faster than hæmoglobin *S* but does not separate from a mixture of *S* and *P*. Under these conditions it cannot be distinguished from hæmoglobin *L*. On electrophoresis in acid *p*H, either in citrate agar or by the open boundary technique, and in resin chromatography, hæmoglobin *L* separates widely from hæmoglobin *A*, whereas hæmoglobin *P* does not separate. Thus hæmoglobins *L* and *P* can be differentiated by these procedures.

In one of the findings of hæmoglobin *P* an extensive family study was made (Fig. 1). The propositus was a 24-year old Bantu female of pure Lokele descent. Originally the Lokele lived on the River Congo, but the propositus and her family had settled in Stanleyville. She was eight months pregnant when first seen and seemed perfectly well. She had three children who were alive and healthy. Laboratory examinations revealed the presence of *Pl. falciparum* in her blood and ankylostoma ova in her stools. She suffered from a moderate hypochromic anæmia, which was corrected by treatment with antimalarials and iron, and the mean corpuscular hæmoglobin concentration rose from 26 to 31·8 per cent, and the mean corpuscular hæmoglobin from 24·3γγ to 31γγ. Her serum iron-level at the end of the treatment was 117γ per 100 ml.

On paper electrophoresis at alkaline *p*H her hæmoglobin separated into two fractions, one hæmoglobin *A* and another moving more slowly in

Table 1. FINDINGS IN A FAMILY IN WHICH HÆMOGLOBINS *A*, *S* AND *P* ARE FOUND AS ADULT VARIANTS, AND IN WHICH A PROPORTION OF THE MEMBERS OF THE FAMILY SHOW SIGNIFICANT TRACES OF HÆMOGLOBIN *F* WITHOUT MICROCYTHÆMIA

Pedigree designation	Name	Sex	Age	Sickle-cell trait	Adult hæmoglobins	Alkali resistant hæmoglobin (per cent)	Red cells (per cu. mm.)	Cell volume (per cent)	Hæmoglobin gm./100 ml.	M.C.H.C.* (per cent)	M.C.V.* (cu. μ)	M.C.H.* (γγ)	Reticulocytes (per cent)	Blood group
I 1	Kamanga	*M*	65	0	*AP*	1·8	4,450,000	41·8	13·8	33	93·8	31	0·6	A_1 N ccDE
I 2	Malasi	*F*	65	+	*AS*	1·6	4,385,000	40	13·5	33·7	91·2	30·8	0·3	A_1 M CcDee
II 1	Salumu Boniface	*M*	31	+	*APS*	3·9	5,080,000	47	15·1	32·1	92·5	29·7	1	A_1 MN CcDee
II 2	Fatuma Justine	*F*	28	0	*A*	<1·5	3,780,000	38	11	28·9	100·5	29·1	0·7	0 MN ccDee
II 3	Yawenda Hiéronyme	*F*	27	0	*A*	<1·5	4,570,000	42	14·3	34	91·9	31·3	0·7	A_1 MN ccDE
II 4	Safi† Yalufi	*F*	25	0	*AP*	6	3,880,000 (3,660,000)	36·2 (11·4)	9·4 (11·4)	26 (31·8)	93·4 (97·5)	24·3 (31)	0·5	A_1 MN CcDE
II 5	Ngulaia Bernard	*M*	26	0	*A*	<1·5	4,480,000	43	13·1	30·5	95	29·3	0·9	0 MN ccDee
II 6	Kilicho Alphonse	*M*	22	+	*AS*	<1·5	5,600,000	46	14	30·4	82·1	26·7	0·2	A_1 MN ccDE
II 7	Aziza Marie-Louise	*F*	19	0	*A*	<1·5	4,025,000	39	12·7	32·5	96·8	33·1	1	0 MN ccDee
III 1	Salumu Albert	*M*	12	0	*AP*	3·1	4,600,000	40	12·7	31·7	86·9	27·6	0·3	A_3 MN CcDee
III 2	Salumu Mélanie	*F*	9	0	*AP*	7·3	4,370,000	38	13·1	34·5	86·9	30	0·6	A_1 MN CcDee
III 3	Salumu Excell	*M*	7	+	*AS*	<1·5	4,390,000	37	13·1	35·5	84·2	29·9	0·7	A_1 MN CcDee
III 4	Salumu Tabu	*F*	6	+	*AS*	1·6	3,365,000	30	8·7	29	89·3	25·9	2	A_2 MN CcDee
III 5	Salumu Félicité	*F*	5	0	*AP*	1·7	4,085,000	37	11·3	30·5	90·5	27·6	2	A_1 MN ccDee
III 6	Salumu Côme	*M*	2	+	*AS*	<1·5	3,600,000	32·5	10·7	32·9	90·2	29·7	0·7	A_1 MN ccDee
III 7	Ngulaia† Boniface	*M*	7	0	*AP*	5·2	3,840,000 (3,500,000)	30 (32)	9·4 (10·4)	31·4 (32·4)	78·1 (91·1)	24·5 (29·6)	1·1	A_1 MN ccDE
III 8	Ngulaia† Christine	*F*	5	0	*AP*	3·9	4,500,000 (4,520,000)	37 (39)	11·5 (12·4)	31·1 (31·8)	82·2 (86·2)	25·5 (27·4)	0·3	A_1 MN ccDE
III 9	Ngulaia† Marie-Colette	*F*	2	0	*A*	19·8	4,520,000 (4,260,000)	37 (37·5)	11·7 (12·2)	31·6 (32·5)	81·8 (88)	25·8 (28·6)	0·4	0 MN ccDE
III 10	Kiditio Marguerite	*F*	2	0	*A*	2·5	4,225,000	39·5	12	30·4	93·4	28·4	0·3	0 MN ccDE
III 11	Kiditio Valerine	*F*	$\frac{9}{12}$	+	*AS*	3·1	4,400,000	36	11·1	30·8	81·8	25·2	0·2	0 N ccDE

* Key. M.C.H.C., mean corpuscular hæmoglobin concentration, M.C.V., mean corpuscular volume, M.C.H., mean corpuscular hæmoglobin.

† The figures in brackets show the results after the removal of hookworms and treatment with antimalarials and iron. In all subjects nothing abnormal was seen in the white cell count, and the serum bilirubin-level was raised.

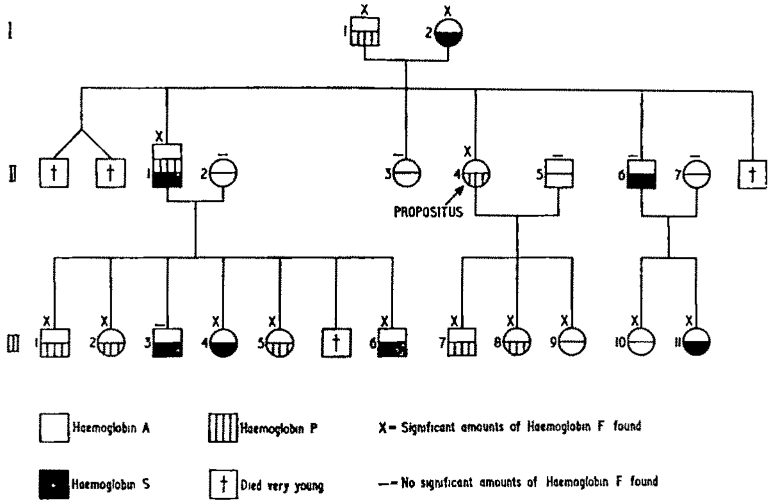
I
II
III
PROPOSITUS
Hæmoglobin A
Hæmoglobin P
X = Significant amounts of Hæmoglobin F found
Hæmoglobin S
Died very young
– No significant amounts of Hæmoglobin F found

Fig. 1

the positions of hæmoglobins *L* or *P*. On resin chromatography at *p*H 6 the hæmoglobin mixture did not separate, although a tail appeared at the rear of the hæmoglobin *A* band, which is the typical appearance of a hæmoglobin $A + P$ mixture. We sent two samples of the patient's hæmoglobin to Dr. R. Schneider, who confirmed by paper electrophoresis at *p*H 8·6 and by open boundary electrophoresis at *p*H 6·4, and by electrophoresis in citrate agar at *p*H 6·0, that the abnormal hæmoglobin had the properties of hæmoglobin *P*.

When the family was examined it became apparent that a number of them showed traces of hæmoglobin *F*, but the hæmoglobin fraction A_2 was always below 3 per cent (Table 1). This applied to the parents of the propositus, to all her children, to one of her siblings, and seven of eight nephews and nieces examined. Two of her siblings showed no hæmoglobin *F*, but two nieces with hæmoglobin *F* were the daughters of one of these siblings. The family tree did not show an association of hæmoglobin *F* with either hæmoglobins *A* or *P*, or with a third hæmoglobin occurring in the family—hæmoglobin *S*. The only case where the amount of hæmoglobin *F* was considerable was that of a niece (III 9)—a two-year old child with 19 per cent fœtal hæmoglobin. There was a slight hypochromia but no serious anæmia, and there was no increase in hæmoglobin A_2 as might be expected in typical thalassæmia.

In one of the propositus' brothers (II 1) four hæmoglobins were found. Alkaline denaturation and resin chromatography at *p*H 6 demonstrated 4 per cent hæmoglobin *F*. On paper electrophoresis at *p*H 8·6 two fractions were seen: hæmoglobin *A*, and another larger, slow-moving component in the position of hæmoglobin *S*. On chromatography at *p*H 6 three fractions were seen, one corresponding to hæmoglobin *F*, and two others: one in the position of hæmoglobin *A* with tailing resembling the appearance of an $A + P$ mixture, and another in the position of hæmoglobin *S*. Whereas the fraction in the position of hæmoglobin *S* had been the largest on paper electrophoresis at alkaline *p*H, it was now smaller than the component moving in the position of hæmoglobin *A*. These findings could be interpreted as indicating the presence of hæmoglobins *A*, *P* and *S*, the *P* moving with *S* on alkaline paper electrophoresis, and with *A* on chromatography *p*H 6. The family study supported this interpretation. This man had married a woman with normal hæmoglobin, and three of his offspring showed hæmoglobins $A + P$, and three others hæmoglobins $A + S$. The genotype $A + S + P$ was therefore borne out by the family study.

Hæmoglobins *S* and *C* have been shown to be determined by allelic genes[2]. Ingram[3], and Hunt and Ingram[4] have demonstrated that the difference between hæmoglobins *A*, *S* and *C* consists in a substitution of different amino-acids in one position of the hæmoglobin half-molecule. The possibility that there might be more than one locus determining specific features of adult hæmoglobin was first suggested by Schwartz and his colleagues[5] to explain the mode of inheritance of hæmoglobins *A*, *S* and what they considered to be hæmoglobin *G*, in a family they had studied. This interpretation has also been proposed by Smith and Torbert[6] to explain their

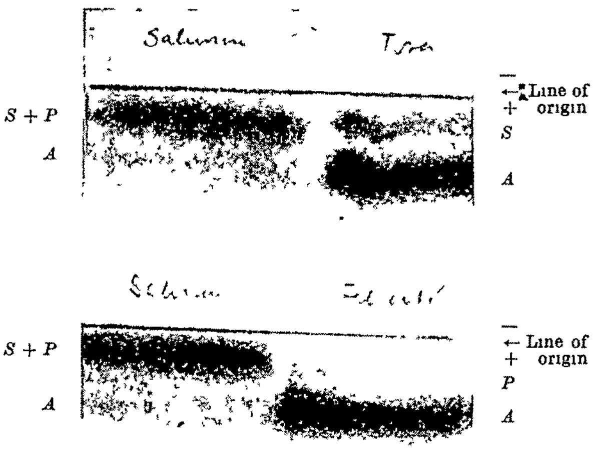

Fig. 2. Paper electrophoresis at *p*H 8·9 (*tris* buffer) showing above II 1 ($A + P + S$) in comparison with his son III 4 (showing $A + S$) and below with his daughter III 5 showing $A + P$. The bands are unstained

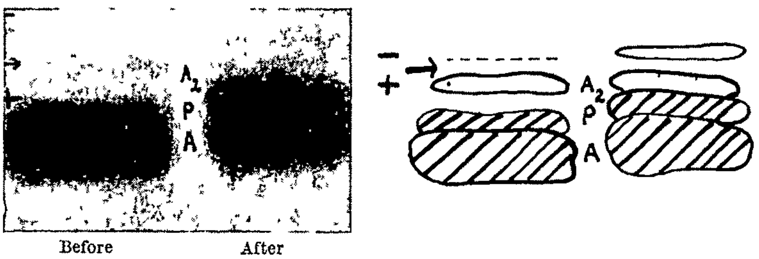

Fig. 3. Hæmoglobin from the propositus ($A + P + F$) before and after dissociation and re-combination. Paper electrophoresis at *p*H 8·9 (*tris* buffer). The bands are stained with 'light green'. In the re-combined specimen a small component is seen moving towards the anode

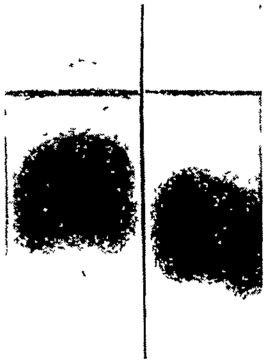

Fig 4 Paper electrophoresis at *p*H 8 6 (barbiturate buffer) showing a comparison between the hæmoglobin of the propositus ($A + P + F$) and a hæmoglobin $A + S$ mixture after dissociation and re-combination The bands have been stained with 'light green' Note that in the specimen from the propositus a fraction is present which moves towards the anode This fraction is not present in the $A - S$ mixture

findings in a family with hæmoglobins A, S and a 'fast' moving hæmoglobin Lastly, Cabannes and Portier[7] have described a family where the mother possessed hæmoglobins A, D and K One of her children was a hæmoglobin D trait carrier, and the other two were hæmoglobin K trait carriers It seems that hæmoglobin P joins the group of adult variants whose inheritance could be interpreted as being under different control from that responsible for hæmoglobins S and C Rhinesmith, Schroeder and Pauling[8] demonstrated that the hæmoglobin A molecule contains only two types of polypeptide chains, and Schroeder and Matsuda[9] have shown that hæmoglobin F also consists of an equal number of two polypeptide chains, one of which has been found by Hunt[10] to be identical with that common to hæmoglobins A, S and C Ingram[11] has pointed out how two non-allelic genes could find expression by one affecting the first, and the other the second, chain Singer and Itano[12] were able to show that exchange of chains between hæmoglobins A, S and C did not result in any 'hybrid' hæmoglobin This one would expect if in all three hæmoglobins one of the two chains was identical On the other hand, if in hæmoglobin P the alteration was not in the same chain which is different in hæmoglobins S, C and F, then a dissociation and re-combination of a hæmoglobin mixture containing hæmoglobins A, P and F should result in at least one 'hybrid' hæmoglobin

Following Singer and Itano[12] a purified solution of hæmoglobin from the propositus ($A + P + F$) was incubated with acetate buffer *p*H 4 6 It was then dialysed against barbiturate buffer *p*H 8 6, and a small amount of precipitate formed during dialysis was removed by centrifugation On paper electrophoresis of the supernatant at *p*H 8 6 a new hæmoglobin fraction was seen moving towards the cathode (Fig 3) This fraction could be eluted and was shown spectroscopically to be a hæmoglobin No such fraction was found when specimens of hæmoglobins $A + S$, $A + C$, and $S + C$ were similarly examined However, when untreated specimens of hæmoglobin from the propositus were submitted to starch electrophoresis where a larger amount of pigment could be investigated, a minute fraction corresponding to the 'hybrid' hæmoglobin was detected (Fig 3) It is not possible to state with assurance that this fraction was not formed on storage of the hæmoglobin solution However, if the 'hybrid' hæmoglobin was an *in vivo* phenomenon, the situation would resemble that known to occur in plants where anthocyanin formation is determined by independent genes, and 'hybrid' pigments can be formed In II 1 ($A + S + P + F$) only the 'hybrid' seen in the propositus was found on dissociation and re-combination of the hæmoglobin mixture Similarly, mixtures of hæmoglobins $A + S$, or $S + C$ with that of the propositus did not result in additional 'hybrids' However, here a large amount of precipitate was formed during dialysis and the soluble fraction had lost most of the non-A hæmoglobins

From the position of these hæmoglobins on electrophoresis at alkaline *p*H, and from the work of Hunt and Ingram[3,4], it is clear that the substituted chains of S and C carry a much stronger positive charge than the characteristic chain of hæmoglobin F, and one might expect their combination with the characteristic P chain to be unstable

We wish to thank Dr A E Mourant and Dr V M Ingram for helpful discussion

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β-GLOBULIN ALLELES IN SOME ZEBU CATTLE

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THREE β-globulin alleles (β^A, β^D and β^E) have been described so far in British breeds of cattle[1] Two further alleles have now been recognized in zebu (*Bos indicus*) breeds It is proposed to call these alleles β^B and β^F

In most mammals the β-globulin alleles give rise to more than one zone by starch-gel electrophoresis[2] Each of the cattle β-globulin alleles β^A, β^D and β^E gives four detectable zones, the most rapidly migrating zone staining faintly with nigrosine, the next staining moderately and the slowest two zones staining intensely The two further alleles which have been detected also give rise to four similarly staining zones The relative mobilities of the groups of four

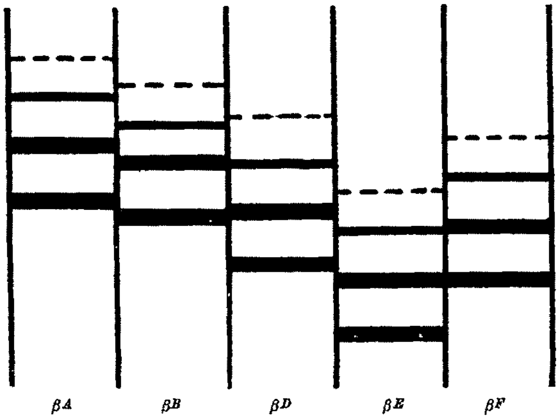

Fig 1 Relative mobility in starch-gel of the four zones produced by each β-globulin allele in cattle The anodic side of the gel is at the top of the diagram, only the β-globulin zones being shown

zones controlled by the five alleles are shown in Fig 1 It will be seen that the zones controlled by β^B are intermediate in mobility to those produced by β^A and β^D, while β^F gives rise to zones intermediate in mobility between those produced by β^D and β^E

Previous experience has shown that each β-globulin genotype formed from the alleles β^A, β^D and β^E gives only one phenotype[1] Fifteen phenotypes would therefore be expected from five alleles, fourteen have been found so far The homozygote of the infrequent allele β^B has not yet been seen The appearance of the phenotypes (Fig 2) was anticipated in the main from the knowledge that the pattern given by a heterozygote is indistinguishable from that given by a simple mixture of the corresponding homozygous sera[1,2]

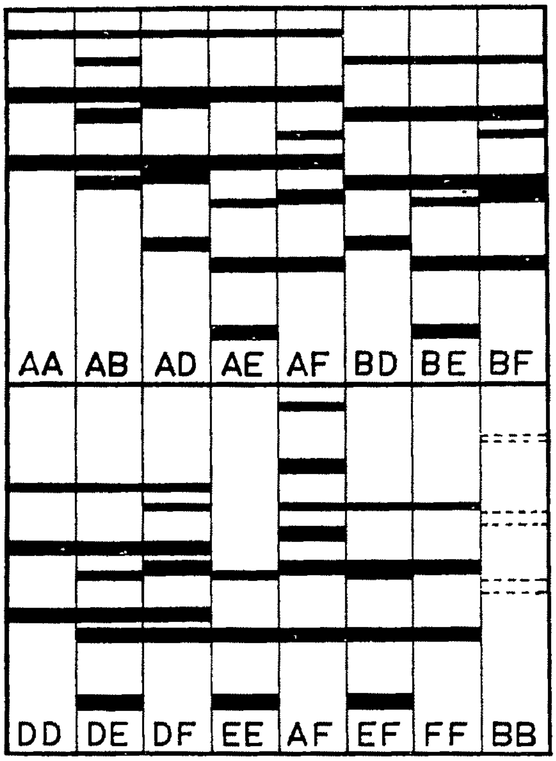

Fig 2 The fourteen cattle β-globulin phenotypes The anodic side of the gel is at the top of each portion of the diagram, only the β-globulin zones being shown The fast-moving faint band produced by each allele (cf Fig 1) is not shown For *AA AB*, etc , read β^{AA}, β^{AB}, etc The dotted zones for β^{BB} (bottom right) show the expected appearance of this phenotype, which has not yet been found

Data from matings between Sindhi × Sindhi, Sahiwal × Sahiwal, Sindhi × Jersey and Sahiwal × Jersey cattle confirm that the previously unrecognized phenotypes represent individual genotypes formed from five alleles (Table 1)

Table 1 Distribution of Phenotypes from Matings involving the Cattle β-Globulin Alleles β^B and β^F

Parents		Offspring		
Dam	Sire	Like dam	Like sire	Recombinants
*AA**	*AF*	3	3	—
AA	*BF*	—	—	1 *AB*
AD	*AF*	1	9	3 *AA*, 5 *DF*
AD	*BF*	—	—	1 *AB*, 1 *BF*
AD	*FF*	—	—	1 *DF*
AE	*AF*	5	0	0
BF	*AF*	1	0	0
DD	*AF*	—	—	1 *AD*, 4 *DF*
DD	*DF*	—	—	1 *DF*
EF	*AF*	0	1	1 *FF*
EF	*DF*	1	1	0

* For *AA*, *AF*, etc , read β^{AA}, β^{AF}, etc

The frequency of each allele for several breeds and crossbreeds of cattle from two herds is shown in Table 2.

Table 2 Showing β-Globulin Gene Frequencies for some Breeds and Cross-breeds of Cattle at F D McMaster Field Station (top) and National Cattle Breeding Station (bottom)

Breed	No of animals	Gene frequency				
		β^A	β^B	β^D	β^E	β^F
Sindhi	14	0 57	0 04	Nil	0 28	0 11
Sindhi × Jersey	29	0 52	Nil	0 24	0 12	0 12
Sahiwal	10	0 10	0 20	Nil	0 15	0 55
Sahiwal × Jersey	31	0 33	0 05	0 28	0 03	0 31
Jersey	51	0 51	Nil	0 49	Nil	Nil
Hereford	27	0 39	Nil	0 52	0 09	Nil
Shorthorn	18	0 56	Nil	0 39	0 05	Nil
Hereford × Shorthorn	10	0 45	Nil	0 55	Nil	Nil
Brahman × Shorthorn	14	0 28	Nil	0 43	0 18	0 11
Brahman × Hereford	15	0 40	Nil	0 24	0 20	0 16
Africander × Shorthorn	13	0 19	Nil	0 50	0 31	Nil
Africander × Hereford	15	0 23	Nil	0 47	0 30	Nil
Brahman*	—	0 3	Nil	0 1	0 3	0 3
Africander*	—	Nil	Nil	0 4	0 6	Nil

* Approximate frequencies computed from remainder of data

It has been suggested previously[1,3] that the frequency of β^E within a breed may reflect the climatic or ecological stress to which the breed is subjected Thus, the frequency of β^E increases in a northerly direction in the British Isles, both within and between breeds The high frequency of β^E in all the zebu breeds examined is particularly interesting therefore in view of the well-known climatic and ecological tolerance of these cattle

I thank the Officer-in-Charge of the F D McMaster Field Station of the Commonwealth Scientific and Industrial Research Organization, Badgery's Creek, New South Wales, and of the National Cattle Breeding Station of the Commonwealth Scientific and Industrial Research Organization, 'Belmont', Rockhampton, Queensland, for supplying blood samples, and C. Bloomfield for technical assistance

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FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, November 23

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 5 p m—Mr Barrie E Juniper "Oxford University Tanganyika Expedition"

Institution of Mechanical Engineers, Education Group (at 1 Birdcage Walk, Westminster, London, S W 1), at 6 p m—Discussion on "Vibration Theory, Linear Systems and the subject 'Theory of Machines'"

Tuesday, November 24

Society for Analytical Chemistry, Physical Methods Group (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m—Mr R A C Isbell "The Design of Optical Instruments for Chemical Analysis"

Royal Aeronautical Society (at 4 Hamilton Place, London, W 1), at 7 p m—Prof D B Spalding "Heat and Mass Transfer in Aeronautical Engineering"

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W 1), at 7 p m—Mr N I Walker "Application of Instrumentation to Glass Melting Furnaces"

Radar and Electronics Association (at the Royal Society of Arts, John Adam Street, Adelphi, London, W C 2), at 7 30 p m—Prof H E M Barlow "Waveguides for Long Distance Communications" *

Wednesday, November 25

Royal Society of Arts (at St John Adam Street, Adelphi, London, W C 2), at 2 30 p m—Sir Christopher Hinton, K B E, F R S, and Sir William Holford "Power Production and Transmission in the Countryside—Preserving Amenities"

Geological Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p m—Mr L R Raymond "The Pre-Permian Floor beneath Billingham, Co Durham", Dr J M Hancock "The Cretaceous System in Northern Ireland"

Institution of Electrical Engineers, Electronics and Communication Section (at Savoy Place, London, W C 2), at 5 30 p m—Dr R L Smith-Rose "Radio Aspects of the International Geophysical Year"

Institute of Physics (at 47 Belgrave Square, London, S W 1), at 6 p m—Mr J F Coales "Education for Automation"

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S W 1), at 6 p m.—Prof A H Cottrell, F R S "The Effect of Nuclear Radiation on Engineering Materials" (Thomas Hawksley Lecture)

Society of Chemical Industry, Food Group (at 14 Belgrave Square, London, S W 1), at 6 15 p m—Mr G E Moss "Fortuitous Corrosion Inhibitor in Biscuit Mixes", Mr G P Seary "Recent Developments in Produce Pre-packaging"

Society for Analytical Chemistry (joint meeting with the Pharmaceutical Society of Great Britain, at 17 Bloomsbury Square, London, W C 1), at 7 30 p m—Meeting on "Methods of Assays of Capsicum, Lonchocarpus and Rauwolfia"

Thursday, November 26

Institute of Marine Engineers (joint meeting with the Society of Naval Architects and Marine Engineers, at the Memorial Building, 76 Mark Lane, London, E C 3), at 3 p m—Mr C C Pounder Human Problems in Marine Engineering", at 5 30 p m—Mr J Zrodowski and Mr H C Andersen "Co-ordinated Alignment of Line Shaft, Propulsion Gear and Turbines"

Institution of Electrical Engineers (at Savoy Place, London, W C 2), at 5 30 p m—Mr T R Manley, Mr K Rothwell and Mr W ray "The Application of Low-Pressure Resins to some High-Voltage Switchgear Designs"

Institution of Mechanical Engineers, Applied Mechanics Group (at 1 Birdcage Walk, Westminster, London, S W 1), at 6 p m—Discussion on "The Application of Creep Results to Engineering Design"

Royal Aeronautical Society (at Church House, Westminster, London, S W 1), at 6 p m—Prof H Schlichting "Some Developments in Boundary Layer Research in the Last Thirty Years" (Third anchester Memorial Lecture)

Thursday, November 26—Friday, November 27

Institute of Petroleum (joint meeting with the Corrosion Group and the Chemical Engineering Group of the Society of Chemical Industry, in the Grand Council Chamber, The Federation British Industries, 21 Tothill Street, London, S W 1), at 9 30 a m ily—Joint Symposium on "Corrosion Problems of the Petroleum Industry"

Friday, November 27

Royal Aeronautical Society (at 4 Hamilton Place, London, W 1), at 7 p m—Dr D R Walkie "Man and an Aero Engine"

Royal Institution (at 21 Albemarle Street, London, W 1), at p m—Dr P T Haskell "Research in the War against Locusts"

Friday, November 27—Saturday, November 28

Botanical Society of the British Isles (at the Lecture Hall, The British Academy, Burlington House, Piccadilly, London, W 1)—Darwinian Centenary Conference

British Society for Immunology (at the Wellcome Foundation, 183 Euston Road, London, N W 1)—Symposium on "Persistence of Immunity" Chairman Dr C H Andrewes

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Assistant Experimental Officers (2) (with a degree in agriculture or pure science with main subject zoology, or the Scottish Leaving Certificate (or equivalent) with passes in five subjects which must include English, Higher Mathematics and Science, and the ability to drive a car) in the Rodent Control Service, Department of Agriculture for Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting Ref G388/9A (November 23)

Graduate Assistant (with appropriate professional qualifications and/or experience) in the College Library—The Principal, Royal Holloway College, Englefield Green, Surrey (November 27)

Assistant Lecturer or Demonstrator (with medical qualifications registrable in this country) in Pathology—The Registrar, The University, Manchester 13 (November 28)

Reader (with a degree in chemistry and a qualification in either pharmacy or a biological subject, a research degree and experience of direction of research in medicinal chemistry) in Medicinal Chemistry—The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S W 3 (November 28)

Senior Lecturer and a Lecturer (preferably with a major interest in applied thermodynamics or applied mechanics, especially the theory of machines) in Engineering—The Registrar, The University, Manchester 13 (November 28)

Assistant Lecturer (with special qualifications or interests in radio astronomy) in Physics—The Registrar, The University, Manchester 13 (November 30)

Lecturer in Organic Chemistry at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (November 30)

Lecturer in Pathology in the School of Veterinary Medicine—The Registrar, Trinity College, Dublin (November 30)

Lecturer or Senior Lecturer in Preventive Medicine at the University of New England, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (November 30)

Lecturer (preferably with teacher-training experience in West Africa or other tropical areas) in Educational Psychology, Nigerian College of Arts, Science and Technology—The Council for Overseas Colleges, 12 Lincoln's Inn Fields, London, W C 2 (November 30)

Lecturer (with a recognized degree in agriculture) in Agriculture—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, near Chelmsford, Essex (November 30)

Research Assistant in the Department of Physics for work concerned with the fundamental study of electroluminescence and related processes in single crystal phosphors—The Registrar, The University, Hull (November 30)

Senior Lecturer (of good academic standing and with industrial and laboratory experience in electrical machinery and automatic control) in Electrical Engineering at the University of Adelaide, Australia—The Registrar, The University of Adelaide, Adelaide, South Australia (November 30)

Technical Officer (with a university degree or comparable qualification in physics or electrical engineering or other aprpoved subjects) in the Department of Physics—Dr F B Kipping, University Chemical Laboratory, Lensfield Road, Cambridge (December 2)

Lecturer (preferably with research interests in autocology and whole-plant physiology) in Botany at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (December 5)

Lecturer in Social Anthropology and a Lecturer in Rural Sociology in the Faculty of Economic and Social Studies—The Registrar, The University, Manchester (December 12)

Senior Lecturer or Lecturer in Physics, and a Senior Lecturer or Lecturer in Inorganic Chemistry at the University of Khartoum—The Registrar, University of Khartoum, c/o Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (December 15)

Lecturer (with an honours degree in psychology, a higher degree in psychology or equivalent qualifications) in Psychology at Canberra University College, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, January 11)

Imperial Chemical Industries Research Fellows in Bacteriology, Biochemistry, Biomolecular Structure, Botany (Plant Biochemistry and Biophysics), Chemical Engineering, Chemistry, Chemistry of Leather Manufacture, Chemotherapy, Colour Chemistry and Dyeing, Engineering (Civil, Electrical or Mechanical), Fuel and Refractories, Geology (including Geochemistry), Metallurgy, Mining (Selective Flotation and Geophysical Surveying), Pharmacology, Physics, Physiology, or Textile Industries (Chemistry of High Polymers (Keratin and Man-made fibres), Textile Technology and Textile Engineering)—The Registrar, The University, Leeds 2 (February 15)

Chemist, Scientific Officer (with an interest in animal nutrition), and Agronomists, one Senior Scientific Officer and one Scientific Officer (with an interest in pasture plant physiology, sociology and assessment in relation to the breeding of new varieties for lowland and upland conditions)—The Registrar, University College of Wales, Aberystwyth

LECTURER IN MATHEMATICS, and a LECTURER IN STATISTICS AND MATHEMATICS—The Registrar, Bradford Institute of Technology, Bradford 7

PHYSICIST (with several years experience with radioactive isotopes), for work upon isotopically labelled steroids—The Director, Endocrine Unit, Institute of Obstetrics and Gynæcology, Chelsea Hospital for Women, Dovehouse Street, London, S W 3

PLANT PHYSIOLOGIST (honours graduate with research experience) IN THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Palmerston North, New Zealand, to undertake research into the biochemical aspects of the physiology of plant growth and development under controlled climate conditions—The High Commissioner for New Zealand, 415 Strand, London, W C 2, quoting Ref No B 11/21/13, and mentioning *Nature*

RESEARCH ASSISTANTS (honours graduates in chemistry), to carry out research work for higher degrees in one of the following (1) the relationship between sorption affinity of alumina for a series of organic solutes in non-polar solvents and certain physical properties of the sorptives or (2) a problem in nitrogen heterocyclic chemistry—The Principal, Derby and District College of Technology, Kedleston Road, Derby

RESEARCH DEMONSTRATORS and RESEARCH STUDENTS IN THE DEPARTMENTS OF BUILDING AND CIVIL ENGINEERING, CHEMISTRY AND APPLIED CHEMISTRY, ELECTRICAL ENGINEERING, LIBERAL STUDIES, MATHEMATICS, MECHANICAL ENGINEERING, and PURE AND APPLIED PHYSICS—The Registrar, Royal Technical College, Salford 5, Lancs

SENIOR TECHNICIAN IN THE MICROBIOLOGICAL LABORATORIES—The Secretary, The Royal College of Science and Technology, George Street, Glasgow, C 1

TECHNICIAN IN THE DEPARTMENT OF BOTANY—The Registrar, University College of Wales, Aberystwyth

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Bedfordshire Naturalist, No 13 (Being the journal of the Bedfordshire Natural History and Field Club, for the year 1958) Pp 48+1 plate (Bedford Bedfordshire Natural History Society and Field Club, 1959) 5*s* [249

British Broadcasting Corporation Engineering Division Monograph No 26 (August 1959) Transistor Amplifiers for Sound Broadcasting By S D Berry Pp 19 (London British Broadcasting Corporation, 1959) 5*s* [249

Philosophical Transactions of the Royal Society of London Series A Mathematical and Physical Sciences No 999, Vol 251 (15 September 1959) Coulomb Gauge in Non-Relativistic Quantum Electrodynamics and the Shape of Spectral Lines By E A Power and S Zienau Pp 427–454 9*s* No 1000, Vol 251 (15 September 1959) Propagation of Elastic Wave Motion from an Impulsive Source Along a Fluid/Solid Interface 1 Experimental Pressure Response By W L Roever and T F Vining 2 Theoretical Pressure Response By E Strick 3 The Pseudo-Rayleigh Wave By E Strick Pp 455–523 23*s* 6*d* No 1001, Vol 251 (15 September 1959) On the Annual Variation of Magnetic Disturbance By D H McIntosh Pp 525–552 10*s* (London Royal Society, 1959) [249

Ministry of Agriculture, Fisheries and Food Fishery Investigations, Series IV An Introductory Account of the Smaller Algae of British Coastal Waters Part 1 Introduction and Chlorophyseae By Dr R W Butcher Pp ii+74+14 plates (London H M Stationery Office, 1959) 25*s* net [249

Oundle School Natural History Society Report, 1958 Pp ii+55 (Oundle, Peterborough Oundle School Natural History Society, 1959) [249

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Planning, Vol 25 (28 September 1959) European Unity—a Review Pp 161–188 (London Political and Economic Planning, 1959) 3*s* 6*d* [309

British Medical Bulletin Vol 15, No 3 (September 1959) Symposium on "Current Virus Research" Pp 175–250+8 plates (London British Council, 1959) 20*s* [309

The Universities a Royal Commission? By Graeme C Moodie (Fabian Research Series, No 209) Pp 52 (London The Fabian Society, 1959) 5*s* [309

Proceedings of the Royal Irish Academy Vol 60, Section A, No 2 A Property of Bounded Regular Functions By P B Kennedy Pp 7–14 1*s* 6*d* Vol 60, Section A, No 3 On the Structure of Multiplet Σ States in Diatomic Molecules By I Kováca Pp 15–26 2*s* Vol 60, Section B, No 4 The Phytoplankton of some Irish Loughs and an Assessment of Their Trophic Status By F E Round and A J Brook Pp 167–191 3*s* 6*d* Vol 60, Section B, No 5 A Comparative Survey of the Epipelic Diatom Flora of some Irish Loughs By F E Round Pp 193–215 3*s* Vol 60, Section B, No 6 The Silurian Rocks of the Devilsbit Mountain District, County Tipperary By R N Cope Pp 217–242+plates 18–21 4*s* 6*d* (Dublin Hodges, Figgis and Co , Ltd , 1959) [309

Other Countries

Cancer Current Literature Index Vol 1, No 1 Pp ii+34 Published every 2 to 3 weeks Subscription price 7 50 dollars (Amsterdam and New York Excerpta Medica Foundation, 1959 Published for the American Cancer Society, Inc , New York) [309

Annals of the New York Academy of Sciences Vol 79, Article 3 Psychophysiological Reactions to Novel Stimuli—Measurement, Adaptation, and Relationship of Psychological and Physiological Variables in the Normal Human By Roscoe A Dykman, William G Reese, Charles R Galbrecht and Peggy J Thomasson Pp 43–107 2 50 dollars Vol 80, Article 2 Hypothermia By A Cecil Taylor and 30 other authors Pp 285–550 3 50 dollars Vol 81, Article 3 Enzymes of Polynucleotide Metabolism By J S Roth and 51 other authors Pp 511–804 5 dollars Vol 82, Article 1 Recent Contributions to Antibacterial Therapy By Paul S Rhoads and 54 other authors Pp 1–190 2 50 dollars (New York New York Academy of Sciences, 1959) [309

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge Série Technique, No 55 Comportement Physiologique du Bétail Laitier Friesland du Haut-Katanga Par M Jottiand, A Lahousse et M Vandenbranden Pp 61+4 photographies (Bruxelles Institut National pour l'Étude Agronomique du Congo Belge, 1959) 50 francs [309

Population Reference Bureau, Inc *Population Bulletin*, Vol 15 No 6 (September 1959) Fertility of College Graduates—a College Study Postscript Pp 101–116 (Washington, D C Population Reference Bureau, Inc , 1959) 50 cents [309

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United States Department of the Interior Geological Survey Bulletin 1046–R Uranium in Sharon Springs Member of Pierr Shale, South Dakota and Northeastern Nebraska By Roy C Kepferle Pp iv+577–604+plates 50–53 Bulletin 1068 Geology of Wabaunsee County, Kansas By Melville R Mudge and Robert H Burton Pp vi+210+19 plates Bulletin 1072–C Coal Resources of Colorado By E R Landis Pp v+131–232+plates 2 and 3 Bulletin 1074–D Geology of Uranium Deposits in Triassic Rocks of the Colorado Platea Region By W I Finch Pp iv+125–164+plates 6–10 Bulleti 1075 Bibliography of North American Geology, 1956 By Rut Reece King Pp iii+554 1 75 dollars (Washington, D C Government Printing Office, 1959) [30

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Transactions of the American Philosophical Society New Serie Vol 49, Part 5 The Anatomy of *Callimico goeldii* (Thomas) Primitive American Primate By W C Osman Hill Pp 116 (Phil delphia American Philosophical Society, 1959) 2 50 dollars [30

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GENERAL EDUCATION IN A MODERN DEMOCRACY

IN his presidential address to the British Association at York on September 2, Sir James Gray pleaded strongly for a wider outlook in the teaching of science and stressed the need for a considered judgment as to the proportion of our total educational effort which should be devoted to the training of scientists and technicians—upon whom we depend for maintaining or extending our standard of living—and the proportion which should be expended on raising the intellectual standards whereby the bulk of the population forms its judgments on matters which are susceptible to personal prejudice or political propaganda Sir James recognized the implications of Dr Trenaman's inquiry into the impact of the mass media and maintained that the key to the problem lies in the schools The responsibility resting on secondary school teachers is not easily exaggerated, and Sir James pointed out that really inspired teachers, working with adequate but simple equipment, would achieve far more for general education than specialists in highly equipped laboratories

In the concluding part of his address, Sir James Gray referred to the possible contribution which the British Association might make to the problem of general education so far as science is concerned, and the attention given to this question was a feature of the York meeting Apart from this, no fewer than three of the presidential addresses to Sections of the Association discussed general or particular aspects of the main problem raised by Sir James A provocative address by Prof J Jewkes to Section F (Economics), for example, examined the question of balance between general education of the population in science and that devoted to the training of scientists and technologists In Section L (Education), Sir James Robertson raised much the same issue in frankly discussing the purpose of our educational effort, while, addressing the Assembly of Corresponding Societies, the Countess of Albemarle discussed the question how the ordinary citizen could prepare himself or herself to live intelligently in a scientific age, and the sources of information and instruction available for that purpose.

The Countess of Albemarle suggested that there are three essential needs for the ordinary citizen awareness of the character of the times in which he lives , some understanding of the methods of scientific research , and some readiness or determination to keep abreast of scientific development and invention As Sir James Gray had already pointed out—and as Dr Trenaman's inquiry shows—the attempt to meet these needs must begin in the schools, and there were other papers read at York which were equally concerned with the way in which this should be done Mr J Maitland, in Section J (Psychology), considered specifically the communication of science to the layman, Mr N F Newbury dealt with the place of science in the primary school before Section L and, before the same Section, Dr K Laybourn, in discussing the training of teachers of science and mathematics and what the schools require, laid his own emphasis on the importance of quality and the decisive contribution which an outstanding or inspired teacher in love with his subject and his job could make

It is, however, instructive to examine some of these fundamental issues debated at York in the light of the Clayton Memorial Lecture which Sir John Wolfenden delivered to the Manchester Literary and Philosophical Society in 1958 He did not attempt a definition of education, but pointed out that it is an essential part of a teacher's duty to instruct his pupils in certain areas of human knowledge and skill This responsibility for instruction is inescapable, and it is obvious that such instruction is what is in the minds of those who raised these issues at York Sir John, however, emphasized that education is, among other things, the influence of one personality on another That has been clearly recognized in the great schools and universities of Britain It is implicit in the comments made at York as to the importance and influence of the great and inspiring teacher

Sir John Wolfenden in this lecture proceeded to discuss some of the implications arising from this influence of the teacher upon immature minds, and much of what he said is important not only in the present context but also in that of the proposal recently advanced for giving votes to young people at eighteen years of age He faces frankly the difficulty of presenting truth objectively, particularly in relation to judgments of value, and no less he recognizes that the immaturity of the minds of our pupils is a fundamental difficulty Because of that immaturity, they are not capable of making up their minds for themselves when confronted with carefully balanced lists of credits and debits, and Sir John believes that of all the demands made on intelligent boys and girls nowadays, this is the one which causes the most unhappiness and strain It is not helpful to withdraw our experience and comparative maturity from them at this point.

Nor does Sir John believe that, in fact, it is possible to do so There is no neutrality in many such matters, and there is force in his suggestion that it may be as dishonest to pretend not to hold views which one does hold as to pretend to hold views one does not Moreover, the significant influence on the young is what a man is and does, not what he says, and what he is and does are inseparately fused with what he believes, with his convictions, principles and faith Tolerance and an open mind are indeed essential to human thought and progress, but they must be understood and practised as positives, not as negatives It is no part of real tolerance, Sir John reminds us, to believe that all opinions are equally valid, or of a genuinely open mind to be empty. Empty minds and closed minds are equally a reproach to the educator, and his final plea is not for preferential treatment for any one set of opinions or doctrines, but for a free, fair chance for all, accepting the risks involved where immature minds are concerned, because in this way we come nearest to being faithful to our immature pupils and to the truth itself.

Sir James Gray suggested that the value of an educational system can be judged by the extent to which it leaves people with a desire to know more about the world at large, and aware of the need—and the possibility—of satisfying this at least in part, by personal effort Obviously, too, a constantly changing environment involves a continuous review of the general pattern of teaching, but apart from this, it is a serious indictment of specialist training in science and technology that it so often leaves the specialist not merely with no knowledge of the humanities but also with no desire to attempt to make good the loss That of itself has not only destroyed the catholicity of intellect without which civilization cannot survive, but it has also contributed to make the scientist and the technologist the tools, first of commercial power, and later of the impersonal power of the State

This argument is developed by R T Rolt in an appreciation of the width of knowledge of I K Brunel with which he concludes his biography of that distinguished and versatile engineer, and his argument found echoes in a recent address of Sir Solly Zuckerman on science and freedom, as well as in Sir Charles Snow's thesis of the two cultures The divorce of the scientist and the engineer from the humanities involves a loss of proportion, and from that springs in some measure their loss of influence, while the door is opened to misunderstandings, doubts and fears which have both shaken man's confidence and weakened his control over events Sir James Gray wisely remarked that no young scientist should be allowed to forget that new discoveries tend to arise from the borderland between different subjects, where the discipline of one is applied to another, but that alone will not suffice. It would seem to follow from Dr Trenaman's study that this question of general education must be tackled in the schools, before specialization begins, if anything effective is to be done

Sir James Gray's address, no less than Sir John Wolfenden's, thus leads directly to the central question which Sir James Robertson discussed What are our schools for? It may still be a more open question than is often admitted, how much of our educational effort should be devoted to the training of professional scientists and technologists, and neither Sir James Gray nor Prof Jewkes denied that we might need to increase the present proportion What they did emphasize was that we should have due regard to the cost, and before we denied, in consequence, to a very much larger fraction of the community a reasonable chance of "seeing life steadily and as a whole", we should be sure, on the basis of impartial inquiry, that the need existed and that the cost is justified.

This question, however, cannot be entirely separated from that of the general education of the community If science is to be of direct cultural significance, it cannot, as Sir James Gray said, shut itself off from one of the main factors which have influenced men's attitude to social problems, and implicit in his address was a suggestion for further inquiry into the way in which scientists might receive this general education, possibly through the activities of the British Association itself If this inquiry supported a wider, and perhaps more biological outlook on general education, very far-reaching re-organization of both schools and universities might be involved, but this could scarcely be undertaken without giving a considered answer to the question, what are our schools for, if not to the corresponding question about the purpose of university education. Even to urge that science can only play its full part in furthering human welfare if it is used, at a very early stage of education, as a means of encouraging a dispassionate but optimistic attitude towards all aspects of human affairs, involves at least an answer to the first question.

Sir James Robertson's survey was largely inspired by the view that we are neglecting the greater task of education for the lesser, though not unimportant, task of instruction, and it should already be clear that many of our present shortcomings arise from this fact, perhaps in part, too, from a failure to realize that what ordinary children need most of all is neither this skill nor that smattering, but just to be humanized and helped even a little way towards civilized living It might well be urged that without this the scientist and technologist, too, are unlikely to contribute much towards meeting the real needs of mankind If, in fact, the main effort of the secondary modern school is diverted from the general education of the ordinary child, no improvements in the extent or quality of further education are likely to repair the damage It is abundantly clear already that the fundamental reason only a small minority of British adults continue their general education is not the lack of facilities but the defects in the education they have already received It is in the schools and the schools alone that the basis of a sound general education can be provided, either for the ordinary citizen or for the specialist

The whole trend of Prof Jewkes's address supports Sir James Robertson's conclusion that until we are content to accept children as they are, we will continue to lose the chance of developing the gifts they have, in our perverse determination to make them manifest powers which in fact they do not possess His second conclusion is endorsed by Sir James Gray's address: in its aims and emphasis our education should reflect, as it does not at present, the inescapable truth that it is for most of us relatively easy to get a job and do it decently, but tragically hard to be good human beings in our communities, our homes and our solitariness It will not be easy to change the emphasis from vocational training to education for life, nor perhaps even possible without a change of heart, but until it is done we can scarcely approach the problem of living with science and the effective use of the spoken or the written word and the visual image

To set Sir James Robertson's plea that the ordinary child needs to be humanized and to be helped towards civilized living against Sir John Wolfenden's plea that it is not helpful to withdraw our experience and comparative maturity from our pupils when they are faced with judgments of value, sufficiently illustrates how much common ground exists in these two approaches and how much depends on the teacher That remains the key problem, and especially how men and women of the right type are to be found and produced Even if the need for Britain to produce more highly qualified scientists and technologists is fully established, the development of general education for the ordinary citizen may still remain the more urgent problem for at least two reasons The production of scientists and technologists of the required qualities is linked with this problem of general education in the schools and the supply of appropriate teachers Moreover, since the general citizen, as the Countess of Albemarle observed, needs increasingly to have some understanding of what science is about, because decisions in public affairs nowadays usually in some measure and at some point involve an assessment of scientific and technical data, the appropriate measures to increase the supply of teachers—and in turn of scientists and technologists—depend very largely on the existence of an informed opinion capable of understanding the action required, and capable of supporting it until it has been carried to a satisfactory conclusion

RESEARCH IN GAS DYNAMICS

Fundamentals of Gas Dynamics

Edited by Howard W Emmons (High Speed Aerodynamics and Jet Propulsion, Vol 3) Pp xiii+749 (London Oxford University Press, 1958) 140*s* net

THE third volume in the Princeton series, "High Speed Aerodynamics and Jet Propulsion", is concerned with the fundamentals of gas dynamics In his preface the editor of the volume describes gas dynamics as a rapidly developing branch of physics and applied mathematics Tsien's introductory chapter, a general development of the equations of gas dynamics but dealing principally with the fluid mechanics of a continuum, amply illustrates the importance of applied mathematics in this field of study All possible combinations of compressible flows, adiabatic or diabatic, irrotational or rotational, steady or unsteady, are considered The last chapter on the flow of rarefied gases, by Schaaf and Chambré, defines clearly the regimes of gas dynamics, develops equations for free-molecule and slip flows and presents experimental data for the slip flow and transition regimes This chapter emphasizes that a broad knowledge of physics is required by a worker in the field of high-speed aerodynamics

Yet any engineer concerned with problems in gas dynamics will question whether Emmons's definition is complete, for while the need for a background in mathematics and physics will be agreed, the development of any branch of fluid mechanics as complex as this one must depend upon verification of analytical work in engineering experiments Crocco's chapter on one-dimensional flow (a 'book' of three hundred pages in itself) supplies a logical analytical development but shows an awareness of this need for experimental data It is surprising that some of the now classical descriptions of one-dimensional compressible flows (for example, the flows in ducts with friction and heat transfer under varying pressure ratios) have not been backed by a great deal of experimental work But Crocco has gathered together some excellent photographs of shock phenomena and presents the results of experiments that this reviewer has not seen before, particularly the work of Frossel. Some interesting experimental data obtained by Neumann and Lustwerk for the 'pseudo-shock' (the complex oblique shock wave pattern with turbulent mixing, which occurs when the boundary layers are thick) are also included, together with a review of the work of Shapiro and his associates on the 'aerothermopressor', a device in which the stagnation pressure of a compressible fluid flow may be increased due to the abstraction of heat (by injection and evaporation of water droplets)

Hayes's chapter on shock waves and gas dynamic discontinuities and that on shock wave interaction by Polachek and Seeger are well written and logically developed (This latter chapter contains some beautiful photographs of regular and Mach reflexions and intersections and of shock refractions) Stever's article on condensation phenomena, again interesting and readable, appears somewhat out of place in a volume in this series, for much of the material deals with steam flows Kantrowitz's chapter on unsteady gas dynamics appears to be a little brief to this reader, a non-specialist in the field, who found the brevity of the last article on the application of pressure waves in heat engines disappointing, especially as the quoted references on this subject are difficult to obtain (There are numerous references elsewhere in the volume to papers produced 'internally' by laboratories This growing practice of referring to unpublished work is to be deplored) Emmons's own individual contribution to the book, on flow discontinuities associated with combustion, is a lucid piece of writing, although the difference in notation between this section and the introduction on general aspects of combustion, by von Kármán, is a little confusing Sir Geoffrey Taylor, with assistance from R S Tankin, provides a section on the Chapman–Jouguet theory of detonation

One surprising omission is the lack of a chapter on the flow of real gases at high temperatures (that is to say, dissociated or ionized gases), although Crocco includes articles on the flow of gases with variable specific heats and gases obeying van der Waals's equation

Most workers in the field of gas dynamics will wish to know how this book compares with Shapiro's volumes on compressible flow, published in 1953, but the comparison is a difficult one to make for Shapiro's book is largely devoted to the teaching of gas dynamics The present volume is aimed at reviewing the state of research in gas dynamics, and will be widely used by specialist research workers in different fields

If any criticism may be made of the new volume, it is the usual criticism of a book by several authors—that of duplication of content material and differing notation (For example, the work by Hawthorne and Cohen, on the effect of heating and cooling a compressible flow, appears in three places) In general the book is of the high calibre expected of the distinguished authors and editor, and all physicists, mathematicians and engineers working in the field will be grateful for the publication of this volume

J H HORLOCK

MICROSCOPES AND PHOTOMICROGRAPHY

The Practical Use of the Microscope

Including Photomicrography By George Herbert Needham Pp xxiv+493 (Springfield, Ill Charles C Thomas, Oxford Blackwell Scientific Publications, 1958) 117*s* 6*d*

Photomicrography

By Dr Roy M Allen Second edition Pp xiii+441 (54 plates) (Princeton, N J D Van Nostrand Company, Inc , London D Van Nostrand Company, Ltd , 1958) 67*s* 6*d*

Applied Microscopy and Photomicrography

By H M Malies Pp 143+12 plates (London Fountain Press, 1959) 22*s* 6*d* net

IN many branches of scientific work the need to take photomicrographs arises both for record purposes and to illustrate lectures and published works It is generally accepted that success in photomicrography primarily depends upon a thorough knowledge of microscopical principles and the correct use of the microscope , it is with this that the book by G H Needham is more concerned From a study of the list of contents, it would seem that in scope and breadth of treatment this would be a most valuable book , unfortunately this does not prove to be the case, for here is one book which definitely cannot be recommended The treatment is unjustifiably dogmatic, and much of the matter is obsolete, for example, the chapter on electron microscopy, which only makes a passing reference to the technique of thin-sectioning Other valuable modern techniques such as phase-contrast and interference microscopy receive only a sketchy treatment

Although the book is profusely illustrated, it is felt that many of the photographs, particularly those of microscopes, are superfluous The essential features in a chapter on binocular microscopes, for example, are certainly not photographs of the stands, but diagrams which give the reader valuable information on, say, the arrangement of the prism trains and path of the light rays It is these features which are conspicuous by their absence The book has not even the merit of correct English or clear explanation to commend it The glossary of microscopical terms included in the book may be taken as representative of the general standard thus it is stated that "there is no connection between the focal length of an objective and its working distance, except that they are directly proportional' ! It seems that there is still need for a comprehensive reference work on microscopy

The other two books may be recommended without reserve Dr Allen's well-known "Photomicrography" appears in a revised and enlarged edition which gives a straightforward account of the principles and practice of photomicrography, including a chapter on home-made equipment which should prove useful to the enthusiast who has not the resources of a fully equipped laboratory at his disposal There is also an adequate section on the purely photographic aspects which should prove valuable to many The book by H M Malies has the great advantage of a low price, but it may be said at once that one gets very good value for money as it gives a clear account of basic microscopical technique There are many good line illustrations and plates A minor shortcoming is the lack of detailed information on the photographic processes involved in the making of a photomicrograph ; I would have liked to see a section on the use of the 35-mm camera included, in view of the increasing popularity of this size of negative for much of the routine photomicrography carried out to-day

S BRADBURY

LOW-TEMPERATURE ENGINEERING

Cryogenic Engineering

By Russell B Scott Pp xi+368 (Princeton, N J D Van Nostrand Company, Inc , London D Van Nostrand Company, Ltd , 1959) 5 60 dollars , 42*s*

THE word 'cryogenic' has come into fashion during the past five years and is intended to embrace all practical applications of low temperatures (say below − 150° C) In fact, it connotes, at the present time, a more restricted field in which the main emphasis is on techniques for the liquefaction and handling of low-temperature rocket fuels and oxidants, and special apparatus for low-temperature research The main fields of industrial low-temperature application, namely, air separation and ethylene production, remain largely outside its orbit This emphasis is clear in Dr Scott's book and arises naturally from the fact that the work of the U S Bureau of Standards Cryogenic Laboratory at Boulder, Colorado, of which he is head, has concentrated on the new applications of very low temperatures

The book is exceptionally valuable because the author combines a masterly understanding of the theory of his subject with access to detailed information on the most modern techniques, which he freely imparts

The chapter on gas liquefaction is useful because of its comprehensiveness and its detailed treatment of heat-exchanger design Hydrogen and helium liquefaction feature largely Gas separation is intentionally given only token reference, but this is compensated for by a useful treatment of gas purification by adsorption

Low-temperature thermometry is covered comprehensively and lucidly, as one might expect from an exponent of the subject

The storage and piping of liquefied gases is discussed in great detail, both theoretically and practically It is probable that the material given will be adopted as the standard text for many years to come

The final chapters of the book contain a compilation of the properties of cryogenic fluids and structural materials at low temperatures, gathered and sifted with the full resources of the National Bureau of Standards

The book is well written, and contains an ample bibliography

G G HASELDEN

A NEW INTRODUCTION TO GEOLOGY

Basic Geology for Science and Engineering
By Prof E C Dapples Pp ix+609 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1959) 76s net

"BASIC Geology for Science and Engineering" is designed to introduce geology to those studying to become geologists, agronomists, or engineers. The scope is wide , except for palæontology, all branches of geology are touched on, although physical geology is given greatest attention More prominence than is usual in a book on general geological principles is given to the soil, a topic which is introduced early in the book and returned to repeatedly in different contexts Indeed, the arrangement of subject-matter throughout is cyclical in character, return being made to different aspects of the same point as knowledge of contiguous subjects is built up This system is intended to facilitate the assimilation of some of the more difficult ideas It is not altogether certain that it succeeds, although it sounds logical, but it is certain that the arrangement is not conducive to rapid reference This is a pity, because the volume contains an impressive amount of up-to-date information, much of which has not found its way into a geological text-book before, and which often seems likely to be of greater interest to the advanced student or even the specialist in need of a quick reminder than to the beginner to whom the book is primarily addressed

At the present time geological research is tending to develop an increasing quantitative bias "Basic Geology for Science and Engineering" will appeal to those who believe that this is an inevitable and desirable change The approach to the subject is essentially analytical, and frequent recourse is made to empirical relationships and the theories and principles of physical chemistry and thermodynamics in introducing and explaining geological processes This approach has the merit that it uses points of view and processes of thought familiar to those whose interest in geology is a by-product of a more fundamental interest in some branch of engineering or other technology

There are those, however, who consider that the variables involved in geological processes are so many and so little understood that we are very far from being in a position to rationalize the subject along rigid mathematical lines—if it will ever be possible to do so Without taking the extremist view that all attempts to introduce quantitative concepts into geology are therefore a waste of time if not actually subversive, there does seem to be a danger that the newcomer to geology may be left with a misleading impression of simplicity, order, and exactitude if he is introduced to the subject by means of a series of mathematical equations Prof Dapples himself mentions the dangers of over-simplification, but he might well have given this point more emphasis One way of doing so would have been to stress the importance of work in the field, an aspect of geology which receives scant attention As a distinguished British geologist is fond of impressing on his students, the best geologist is the one who has seen the most rocks, and there is no doubt that familiarity with rocks, especially in the field, induces a healthily corrective scepticism towards glib generalizations, however elegant

So long as the limitations of the mathematical approach are borne in mind, "Basic Geology for Science and Engineering" will fulfil a useful purpose, but as an introductory text-book it will probably be of greater value to engineers than to those whose primary interest is geology.

The reading lists are compiled almost exclusively from North American sources

J C M TAYLOR

DIELECTRICS

Progress in Dielectrics
Vol 1 Edited by Dr J. B Birks and Dr J H Schulman Pp x + 312 (London Heywood and Co , Ltd , 1959) 70s net

THIS book is the first volume of a series which is intended to appear annually The present volume contains four reviews which cover fairly completely the recent advances concerning electric breakdown, two articles on ceramics and one on electrophoresis The editors appear to aim at the experimentalist with theoretical interests

The first article, on "Dielectric Breakdown in Solid Insulation", by J H Mason, brings up to date a subject last summarized by S Whitehead in 1951 The author assumes a knowledge of Whitehead's book and concentrates on recent work, in much of which he has played an active part The review is comprehensive and includes very recent work on electromechanical breakdown in plastics and thermal impulse breakdown in glass For the electrical engineer there is much practical information regarding breakdown by internal and surface discharges and electrochemical deterioration.

"Dielectric Breakdown Effects in Crystals" is very much the preserve of its reviewer, J. W Davisson The subject is essentially academic and involves both advanced theory and refined experimental techniques Davisson reviews recent work since Whitehead's book, and is careful to state fairly the conflicting views on controversial subjects, such as the theories of path formation

"The Electric Strength and High Field-Conductivity of Dielectric Liquids", reviewed by T J Lewis, is a very difficult subject, because much of the experimental material is contradictory The author, who has great experience in the field, does his best to explain the reasons for the discrepancies, but even so, the reader is left a little bewildered by the many sources of experimental error and the many alternative theories However, just in this kind of subject it is very helpful to have a critical review

The review of "Gaseous Dielectrics" by T W Liao and R E Plump is concerned not only with electric breakdown, but also with physical and chemical properties such as heat transfer and flammability It is a merit of this review that it treats physical and chemical considerations with equal interest, and that it brings out the general principles of its subject in an easily intelligible way The article contains also a number of useful practical considerations

The article on "Ferroelectricity of Barium Titanate Crystals" by A D Franklin is perhaps not quite as useful as the others because its subject cannot easily be separated from ferroelectricity in general, a subject which has been widely reviewed recently, both from the crystallographic and electrical point of view In the circumstances it might have been better if the article were more chemical and technological than it is, even though there are some useful references to chemical preparation

"Non-oxide Ceramic Dielectrics" by P Popper would seem to contain rather too much theory which is not immediately relevant However, it is useful to have information on this interesting new subject by an author who is actively engaged in research on it

"Electrophoretic Deposition of Insulating Materials", reviewed by J B Birks, is a practical subject which involves much chemical 'feel'. The author succeeds in presenting the relevant theoretical background of his subjects clearly and concisely, which is useful since colloid science is generally treated in a biological context The article gives a helpful survey of the practical applications

V. Daniel

EMBRYOLOGY

A History of Embryology

By Dr. Joseph Needham Second edition, revised with the assistance of Dr Arthur Hughes Pp 304+18 plates (Cambridge At the University Press, 1959) 52*s* 6*d* net

THIS new edition of Dr Needham's remarkable contribution to the history of science will be widely welcomed Its first appeal is to professional biologists, who will (or should) want to know more about the way their own science found its way out of abysmal ignorance and superstition towards greater knowledge and understanding, and historians of science will find it an indispensable source-book

But it is important for wider reasons It is important for the general historian, who will find in it numerous illustrations of the social relations of science One that I found illuminating was the fact that in the seventeenth and eighteenth centuries there was a widely held conviction (abundantly justified by later events) that research into the nature of generation would throw light on orthodox theological doctrines, such as that of 'original sin', and that this "led to an economic situation of value for biological development" To-day it is devoutly to be wished that the powers that be, including public opinion in general, would extend this conviction and realize that research in biology will throw light on the central problem of man's nature and destiny

The historian will also find many examples of the unfortunate political and social results of wrong attitudes to science and technology, for example, the contempt of antiquity for the 'base mechanic' and his arts, and the recurrent incomprehension of science and scientific method by governments and dominant classes As Sir Charles Snow has so pithily pointed out in his recent Rede Lecture this incomprehension between the professional scientists and the representatives and products of so-called humane studies can be mutual, and in Britain has led to the development of two cultures within the one nation

It would seem that the only way to heal this split is through some reform of education, aimed at the integration of the sciences and the humanities in the cultural process, and many of us feel that for this the historico-evolutionary approach is necessary

The evolutionary concept links man with the rest of life, mind with matter, contemporary history with archæology, while the history of science and its gradual invasion of new fields can be the bridge between the scientific and other elements in human history. Books like Dr Needham's are of the greatest value in helping to realize this process of our cultural re-education and re-integration

Julian Huxley

FOURIER SERIES

Trigonometric Series

By Prof. A Zygmund. Second edition Vol 1 pp xii+383 Vol 2. pp vii+354 (Cambridge At the University Press, 1959) 84*s* net each volume

ZYGMUND'S authoritative treatise, which first appeared as a single volume in 1935, has been thoroughly revised and much enlarged for this second edition The first volume contains practically everything which was in the original edition The essential foundations on convergence and summability are dealt with in the earlier chapters, the reader needs a firm grasp of the elements of point-set theory and of Lebesgue integration The main results are illustrated in a good chapter on special Fourier series The rest of the first and the whole of the second volume deal with special problems and topics, much of the material in the second volume being work done during the past thirty years, showing, in particular, the influence of Littlewood and Paley Each chapter is closely packed, and only the very indolent will ignore the additional wealth of content available in the annotated exercises

The author marshals his material skilfully A good example is his chapter on interpolation of linear operations, where the Riesz–Thorin interpolation theorem and the famous Riesz–Fischer, Hausdorff–Young and Riesz theorems which interpret and generalize the Parseval formula

$$\frac{1}{2\pi}\int_0^{2\pi}|f|^2dt = \Sigma|c_n|^2$$

for a function f with Fourier coefficients c_n, are neatly stitched together and embroidered with Paley's remarkable theorem on Fourier coefficients and the Hardy–Littlewood theorems on re-arrangement of Fourier coefficients His chapter on multiple Fourier series emphasizes the need for significant rather than obvious generalizations

Even where the ground has been well ploughed, some problems remain For example, it is now more than eighty years since du Bois-Reymond constructed a continuous function with a Fourier series diverging at one point, the extension to divergence at an everywhere-dense set of points followed easily enough, but so far all such sets have been of zero measure The question still stands Can a continuous function have a Fourier series which diverges at all points of a set of positive measure? A similar problem was solved some thirty years ago by Kolmogorov, with a delicate argument producing an integrable function with a Fourier series diverging everywhere

In its new form, beautifully produced by the Cambridge University Press, this book remains the standard and indispensable text for any analyst interested in Fourier series for their own fascinating sake

T. A. A Broadbent

Beitrage zur Neotropischen Fauna

Herausgegeben von Prof Dr Erich Titschack und Dr Hans-Wilhelm Koepcke 1 Band, Heft 3 Zur Kenntnis der Pseudoscorpioniden-Fauna des Andengebietes Von Max Beier Pp 185–228 Kritische Untersuchungen der Newportia-Arten Von Wolfgang Bucherl Pp 229–242 Ein neuer *Asthenes* (Aves, Furnariidae) von der Kuste und dem westlichen Andenabhang Sudperus Von Maria Koepcke Pp 243–248 Beitrage zur Kenntnis der Fische Perus II Von Hans-Wilhelm Koepcke Pp 249–268 (Jena · Gustav Fischer Verlag, 1959) 10 95 D M

THE first two papers in the above collection which continues this important new publication are of considerable interest to students of the multitudinous neotropical invertebrate fauna Dr Beier deals with a rich collection of pseudoscorpions from isolated regions of the Andes, especially Peru This region appears to be the developmental centre of genera like *Stenolpium* and *Parawithius*, while in Chile the nearctic genera like *Dinocheirus* fade out There are many endemic species here, and Dr Beier has found it necessary to make several new genera, all of which appear to be soundly based Whether the Pseudoscorpions show replacement of species by altitude is difficult to determine this is shown by such animals as some of the Chilopods, but unfortunately few of Beier's specimens have altitude data with them The new genus *Teratolpium* is found at high altitudes only, but conversely *Pachyolpium granulatum* Beier is found from 700 to 1,630 metres It is to be wished that, where a choice was available, the type specimen chosen should have been one from a known altitude (cf *Progarypus peruanus* Beier) Problems for future investigation may be glimpsed here and there, for example, *Lamprochernes*, a genus of world-wide distribution, has a species high up in the Andes, while *Apolpium vastum* Beier has been found only on orchids Bucherl's very important revision of the Scolopendromorph genus of Centipedes, *Newportia*, places the systematics of this group on a satisfactory basis for the first time The three subgenera *Newportides*, *Scolopendrides* and *Newportia* had been used or not by previous authors almost according to taste or fancy Bucherl shows quite conclusively that they apply to well-marked groups of distinct geographical range A really workable key covers all the known species and sub-species and entails several changes of attribution and status F A TURK

Crushing and Grinding

A Bibliography Pp ix+425 (London H M Stationery Office, 1958 Published for the Department of Scientific and Industrial Research) 35*s* net

THIS bibliography will be invaluable to the very many industrial users of the processes of crushing and grinding and to research workers interested in comminution, particle size determination and particle classification The bibliography proper is preceded by short authoritative reviews on fundamental aspects of crushing and grinding, problems of breakage and structure of coal, methods of particle size analysis, industrial grinding; crushing and grinding in the ceramic industry, grinding in the cement industry, crushing and grinding of minerals, grinding in the field of dyestuffs and organic chemicals, fire and explosion hazards in crushing and grinding operations The sections into which the bibliography itself is divided (with the number of references in each section shown in brackets) are fundamental aspects (450), crushing and grinding practice (354), coarse reduction (154), fine reduction (579), non-mechanical methods (63), materials (744); methods of particle size and surface area determinations (186), classification (160), dust and fire hazards (141) Nearly every reference is accompanied by a useful abstract There is a name index and a comprehensive subject index The Department of Scientific and Industrial Research and the small committee, under the chairmanship of Mr A S White, appointed to advise on the planning of the work, together with Mr W H Bickle, who undertook most of the detail of the work, are to be congratulated on this compilation This is the second bibliography published by the Department of Scientific and Industrial Research on unit operations—the first was on industrial drying (1951), it is to be hoped that further similar bibliographies will be produced S G WARD

River Pollution

1 Chemical Analysis By Dr Louis Klein Pp ix+206 (London Butterworths Scientific Publications, New York Academic Press, Inc, 1959) 30*s*, 3 50 dollars

THIS book is an expansion and revision of two chapters which appeared in an earlier work concerned with the general aspects of river pollution The pollution of the rivers of Britain has been widely discussed during recent years both in lay and scientific circles While it may well be true that "one photograph, particularly if it is in colour, may be worth a hundred dissolved oxygen samples in so far as securing public support or influencing a jury is concerned", the satisfactory resolution of the many problems involved can only be achieved after recourse to analytical methods

Dr Klein deals in this text with physical and chemical methods for the analysis of waters, sewage and trade wastes, biochemical methods are not considered The recent recommendations of the official "Methods of Chemical Analysis as applied to Sewage and Sewage Effluents" and the "Recommended Methods for the Analysis of Trade Effluents" prepared by the Joint Committee of the Association of British Chemical Manufacturers and the Society of Analytical Chemistry are incorporated No attempt is made to give detailed procedures but the many methods available are discussed critically and the most suitable method for a particular problem is indicated The bibliography contains nearly 600 references to the literature The appendix includes tables of saturation values for dissolved oxygen, conversion tables for various units of measurement, including degrees of hardness, tables of alkali conversion factors and various volumetric factors, and some typical analyses of waters and effluents

There seem to be few errors, one, common to many text-books, is that ferroin can be used as indicator in the dichromate-ferrous titration Unless an unusually high acid concentration is used the end-point is poor The book would be of greater practical importance had experimental detail been given for the more widely applied methods However, it should certainly prove a valuable guide to the literature of this important field R BELCHER

Bumblebees

By Dr John B Free and Dr Colin G. Butler With two appendices by Dr Ian H H Yarrow (The New Naturalist. a Survey of British Natural History) Pp xiv+208+25 plates (London William Collins, Sons and Co, Ltd, 1959) 25s net

IN their preface the editors express the hope that this book will widely encourage naturalists to take up the study of bumblebees, and it is indeed a stimulating work Much information is given in an easily understood form, and possible answers to problems as yet unsolved are suggested This eagerness to press forward on to untried ground does, however, occasionally lead the authors into making assumptions which are not entirely justified by the available experimental results Certain over-simplifications also occur in places, as, for example, on p 66 in the description of an experiment by Dr Free, which was designed to test whether bumblebees entering a strange colony can be recognized by their scent alone Reference to the original paper shows that the results were less clear-cut than stated here Nevertheless, in assessing the overall scope and value of the book these criticisms prove to be relatively unimportant

The development of colonies from their inception in the spring until the final hibernation of the mated young queens is described and, as in other chapters, the descriptions are illustrated by numerous original photographs Among other topics discussed are the division of labour, collection of food, recognition of intruders in the nest, and predators and parasites Not only are the biology and behaviour of bumblebees considered, however, for there is also an interesting chapter on their economic importance, in which their value as pollinators of crops and in plant-breeding is reviewed, various suggestions are also put forward for increasing their numbers in farming areas

Two appendixes by the authors on methods of collecting and rearing colonies contain much useful practical information, while a further two appendixes by Dr Ian Yarrow give a simple key to the British species of *Bombus* and *Psithyrus* and details of their distribution. M. Delia Allen

Foundations of Set Theory

By Prof Abraham A Fraenkel and Prof Yehoshua Bar-Hillel (Studies in Logic and the Foundations of Mathematics) Pp x+415 (Amsterdam North-Holland Publishing Company, 1958) 42 guilders, 84s.

Axiomatic Set Theory

By Prof Paul Bernays With a Historical Introduction by Prof. Abraham A Fraenkel (Studies in Logic and the Foundations of Mathematics) Pp. vii+226. (Amsterdam North-Holland Publishing Company, 1958) 45s

THESE two books are the latest in the series of Studies in Logic and the Foundations of Mathematics, produced by the North-Holland Publishing Co The first opens with a short chapter on the paradoxes of set theory and then proceeds to the axiomatic foundations, including the axiom of choice, the axiom systems of von Neumann, and of Bernays and Godel are discussed There is a chapter on type-theoretical approaches, containing developments by Quine, Wang, Lorenzen and others, and an interesting section on set theories based on non-standard logics Here, in particular, is a discussion of the rather obscure ideas of the Polish logicians, Leśniewski and Chwistek About seventy pages are devoted to intuitionistic conceptions of mathematics, and the bulk of the discussion concerns, of course, the ideas of Brouwer. The final chapter is concerned with metamathematics and semantics The bibliography, extending to fifty pages, covers comprehensively the years 1947–56, and will probably become the standard for this period

"Axiomatic Set Theory" is, apart from the introduction by Fraenkel, largely a presentation of a modified form of the material published by Bernays over the years 1937–54 in the *Journal of Symbolic Logic* It is a formal development and is carried out in detail in its applications to analysis, including the theory of real numbers, and to cardinal arithmetic The book is, as the author says, "designed for a reader who has some acquaintance with problems of axiomatics and with standard methods of mathematical logic"

To the 'working mathematician' these two volumes will indicate something of the great amount of effort which, in recent decades, has been expended in the field of symbolic logic and the foundations of mathematics The situation is still very fluid, and it appears that "the third foundational crisis that mathematics is still undergoing" is far from becoming a thing of the past L S Goddard

Elementary Statistical Physics

By Prof. C Kittel Pp ix+228 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1958) 64s net

THIS book contains a short but concentrated treatment of a wide field of theoretical physics Part 1 (116 pages) deals with classical and quantum statistical mechanics and its relation to thermodynamics, Part 2 (52 pages) with fluctuations, random processes in general (including the Wiener–Khinchine theorem), Brownian motion, noise and irreversible processes, and Part 3 (46 pages) with detailed balance, kinetic and transport theory. The three parts are divided into a total of 45 sections, many of which are preceded by references to standard works and recent papers

The exposition is usually clear and as simple as the topic permits, though there is an exception on p 19 where the law of increasing entropy is discussed before the entropy of a non-equilibrium state is defined The amount of application to particular problems is inevitably small in relation to basic theory Assemblies of non-interacting particles only are considered, except for an example on a linear ferromagnet in the section on the density matrix and an appendix proving the virial theorem of Clausius. However, where possible, the author discusses both knotty points and recent developments, as examples may be mentioned sections on the thermodynamics of magnetization and negative temperatures, respectively Problems are given, but some of these seem to be intended more as invitations to follow up the references than as exercises on the text For example, after no more formal definition of a Markoff process than the statement that the two-event probability function p_2 "contains all the information we need" the student is asked to prove the Smoluchowski (Chapman–Kolmogoroff) equation

The book may be recommended for readers who wish to find out about some of the great variety of problems and methods in modern statistical physics G M Bell

MYXOMATOSIS: PRESENT POSITION AND FUTURE PROSPECTS IN GREAT BRITAIN

By Dr. C. H. ANDREWES, F.R.S.
National Institute for Medical Research, Mill Hill, London, N.W.7

AND

H. V. THOMPSON and W. MANSI
Ministry of Agriculture, Fisheries and Food

SINCE the introduction of myxomatosis into Australia and its destruction of millions of rabbits, the situation there has fundamentally changed, and with a startling rapidity. The virus has become attenuated so that more rabbits survive; and still more important, natural selection has ensured that the present population of rabbits has a greater innate resistance to the disease. As a result of these two factors, myxomatosis is no longer regarded as of great value in keeping down the rabbits in Australia. Workers in that country[1,4] have studied the changes in the virus and in the rabbits in a most imaginative and painstaking manner, and in consequence we now have a fairly clear picture of developments there.

Course of events in Britain. In Britain, the history of myxomatosis appears to be following a rather different course. This is doubtless due mainly to the fact that the effective vector here is, for the most part, the rabbit flea (*Spilopsyllus cuniculi*), whereas in Australia mosquitoes are the principal vectors and *Spilopsyllus* is not present.

When the disease first spread in Britain in 1954–55 it did not sweep over the country but was gradually distributed in a patchy manner and the natural local spread was slow but effective: so effective that, by the end of 1955, the great majority (well over nine-tenths) of the wild rabbits had been killed by the disease. Of course, pockets of susceptible rabbits escaped infection and continued to breed, as did the animals recovering from infection.

There were few reports of myxomatosis in the first months of 1956, but what may be called secondary outbreaks were soon evident and, as shown in Table 1, have since appeared in many places. Curiously enough, the only English counties having little or no secondary myxomatosis have been in the west and south-west, whereas the only Welsh counties ever reporting secondary myxomatosis have been the five on the west coast. It was possible to say, in 1956, that there were no really heavy rabbit infestations on the mainland, but during the past three years rabbits have gradually increased, so that there are now considerable populations in some areas and damage to crops is more frequently reported.

Samples of myxoma virus collected in the field have been sent to Prof. F. Fenner at the Australian National University, Canberra, since October 1953 and two of these, sent in September 1954 from Sussex, were somewhat attenuated[1]. The first evidence of extensive infection with attenuated virus was in Sherwood Forest, Nottingham, in April 1955[2], and other cases have since been found in many areas (see Table 1). The British attenuated or atypical myxoma usually produces a nodular lesion with less diffuse œdema than in typical cases. During the early stages the nodules may contain fully virulent virus, but when they shrink and form scabs they contain virus of reduced virulence. By means of the gel diffusion precipitin test[3] cases of typical and atypical myxoma may be rapidly distinguished and the stage of the infection assessed.

Table 1. NUMBER OF COUNTIES IN ENGLAND AND WALES WITH OUTBREAKS OF MYXOMATOSIS

Year	Virulent disease	Attenuated disease	(No. of incidents)
1956	21	5	(24)
1957	36	10	(42)
1958	47	22	(106)

The connexion between the virulent and attenuated strains is at present by no means clear. In the Sherwood Forest area myxomatosis has persisted continuously since 1954 and both typical and atypical infections have been present since 1955. In the Edenbridge area of Kent, on the other hand, there was no secondary outbreak of disease from 1954 until March 1958, despite the marked increase in the rabbit population, although isolated cases of infection were found. In 1958 the Edenbridge rabbits were greatly reduced by disease which was typically virulent for the first four months, after which the presence of atypical infection was also demonstrated.

Changes in virulence of the virus. As Fenner and Marshall have shown, the attenuation of myxoma virus in Australia is a logical consequence of the relationships existing between virus, host and vector. A rabbit bitten by a mosquito which carries a relatively avirulent virus will survive longer than one infected with a more virulent strain and will, therefore, be able to serve longer as a reservoir of infection; virus will thus be carried by more mosquitoes to other rabbits. In Australia natural selection thus tends to favour an attenuated strain. In fact, fully virulent viruses deliberately introduced into areas where less vicious ones are already prevalent will dominate the scene for only a short time[4]; the less virulent ones supplant them in a matter of months. Virus which is too attenuated, however, causes lesions which apparently cannot serve as a good source for virus: so the tendency is towards domination by strains of intermediate virulence.

As already mentioned, attenuated myxoma virus has appeared in some areas of Britain and is on the increase, but modified strains have not, as in Australia, steadily ousted the highly lethal ones. After six years, the latter seem to be at least as numerous as milder ones. This might have been predicted from the nature of the virus–flea–rabbit relationship, which presents notable differences from the virus–mosquito–rabbit system in Australia. In contrast to the Australian situation, there is likely to be some evolutionary pressure in favour of a virulent virus. Fleas on rabbits infected with such a strain will naturally leave the rabbit when it dies and spread the highly lethal virus Where, however, a rabbit survives, the *Spilopsyllus* may have no occasion to seek a fresh host Even if the rabbit dies after a chronic illness, there may well be only a little virus on the flea's proboscis at that stage On a short-term basis survival of the highly lethal virus could thus be favoured Marshall and Fenner[5] have made suggestions on similar lines

This, however, can scarcely be the end of the story For, as Theobald Smith taught, a parasite which kills all its victims will soon perish for lack of fresh hosts to infect There will thus be a counteracting long-term tendency to perpetuate a not too virulent virus In practice there have been several instances where, at the beginning of a myxomatosis outbreak, highly lethal virus has been recovered, whereas in samples obtained later in the outbreak attenuated virus has predominated Rabbits with attenuated virus may be ill for a long time and the virus may persist in attenuated form by exchange of infected fleas in burrows The resultant of opposing evolutionary tendencies may well be a mixture of highly lethal and attenuated viruses existing side by side in the same locality Such a result could be brought about if the favoured virus were one which, as regards virulence, was genetically unstable , but what will in fact be the outcome, only time and alertness of investigators can reveal.

Changes in resistance of rabbits In Australia, a standard virus which originally killed 90 per cent of wild rabbits was only able, after the population had been exposed to seven successive epizootics, to kill 30 per cent of currently caught young ones[6] This tremendous increase in resistance seems to be of more practical importance than any change in the virus , and infection with myxomatosis has now become a minor factor in controlling Australian rabbits despite the fact that there is usually an epizootic each summer The British results summarized above do not suggest that any such change has occurred among our rabbits. One wonders, indeed, whether this would be expected in a population of hosts with an average life-span of about a year and with outbreaks of disease at irregular intervals which may, as around Edenbridge, be as long as four years

Discussion The main object of this article is to try to dispel the idea that myxomatosis here is bound to behave just as it does in Australia There is already good evidence that it is not doing so, and possible explanations of this have been brought forward We do not know how the virus persists between outbreaks and how it manages to re-appear after an apparent absence when rabbit numbers have materially increased It could conceivably persist in a modified form in an immune population or in some biting arthropod , but evidence is lacking that either method is actually possible over a period of years It could also be introduced on rabbit fleas temporarily carried on migrating birds, or on wind-dispersed, infected *Anopheles maculipennis* (= *A atroparvus*) since these mosquitoes are known to be vectors in southern England, though of minor importance compared with fleas Their role is believed to be rather greater in France, and if this is in fact so, myxomatosis there may have a different future from that in England. There remains the possibility of deliberate introduction by man, even though the Pests Act of 1954 made it an offence to use a rabbit infected with myxomatosis to spread disease among uninfected rabbits Few would deny that the indiscriminate spreading of the disease is undesirable, particularly in the absence of much more knowledge about the infection and the long-term consequences of its introduction In any event we must admit that we do not know which, if any, of the agencies discussed are adequate to account for the persistence of the disease and its re-appearance at times after a considerable absence

The increase in rabbit damage to crops in 1959 serves as a reminder that, despite myxomatosis, the rabbit population of Britain is again rising Much useful control has been possible by the concerted action of landholders through Rabbit Clearance Societies , there are now 370 of these, covering seven million acres of land or about 15 per cent of the agricultural area of Britain it would be most unwise to relax such efforts Above all, it is of tremendous importance for the future of farming in Britain that we should learn more of the natural history of myxomatosis and the factors making for changes in the virus and in the rabbits Myxomatosis provides an unusual opportunity to study and compare the evolution of a host–parasite relationship in the contrasting environments of countries at opposite ends of the Earth

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INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

SPECIAL INTERNATIONAL GEOPHYSICAL YEAR MEETING

AS part of the oceanographic programme for the International Geophysical Year the onus of carrying out a Polar Front Survey in the North Atlantic Ocean was placed by the Comité Spécial de l'Année Géophysique Internationale (the body established by the International Council of Scientific Unions for the planning of International Geophysical Year operations) on the International Council for the Exploration of the Sea with the help of the International Commission for the Northwest Atlantic Fisheries A sub-committee of the International Council for the Exploration of the Sea under the chairmanship of Dr G Bohnecke (Federal Republic of Germany) co-ordinated the research plans of the different countries, and forty-six research and other ships of eleven nations took part in the survey At a meeting held under the chairmanship of Dr J B Tait (Britain) at the Council's headquarters in Copenhagen during October 1–3, 1959, 45 papers were presented dealing with the first results of the survey

About sixty attended the meeting, and Mr A J Lee and Dr D H Cushing (Britain) acted as reporters

Hydrography

The hydrographical papers were given in groups, according to geographical regions

Barents Sea The paper by Prof I Hela (Finland) described Finnish work at the beginning of the International Geophysical Year Various sections were worked and can be compared with those of the German research ship *Poseidon* in 1927 The temperature and salinity of the Atlantic water penetrating the Barents Sea were higher in 1957 than in 1927 An increase in salinity of 0 04 per mille on the standard values of all the basic water masses was observed , surface temperatures and salinities were higher than the average values given in the atlas by Dr Krauss Mr A J Lee showed that the volume transport of the West Spitsbergen Current was below normal taking the International Geophysical Year as a whole, and that temperatures in the south-eastern Barents Sea were subnormal He related this state to the abnormally strong development of the Polar high-pressure system and the southward displacement of the atmospheric Arctic Front Norwegian work in the area during various seasons was described in a paper by Mr L Midttun (Norway) which was read by title.

In the first of two papers on the chemistry of Barents Sea water, Dr S Gripenberg (Finland) found that the alkalinity/chlorinity ratio was higher in the Norwegian coastal water than in the Atlantic water or the East Spitsbergen Current, but that the reverse applied when the boron/chlorinity ratio was considered this implies that most of the boric acid is bound up in organic complexes In the second paper, Dr A Voipio (Finland) showed that different methods of analysis gave different results for the total iodine content of sea water and demonstrated how little we know about the iodine content of sea water

Greenland and Norwegian Seas Drs T I Gorshkova and E V Solyankin (U S S R) showed that the deposits on the sea-bed, by differing in their chemical composition, particularly in their content of carbonates and of iron and manganese oxides, are indicators of the hydrographic conditions prevailing in the basins of these two seas Dr J N Carruthers (Britain) pointed out the pioneer use by Otto Pettersson of this technique In a paper read by title, Dr G N Zaitsev *et al* (U S S R) have computed the water and heat budget of these seas When the various components are summed, the difference between the heat input and output amounts to only 0 4 per cent The authors then proceed to show the relative importance of these different components in different parts of the seas · advection of heat by currents is found to be the most important Finally, they have computed the nutrient salt budget Dr A P Alekseev *et al* (U S S R) described Russian hydrographic work in the southern part of the Norwegian Sea in 1958 In April the East Iceland Arctic Current was strong, blocking the inflow of Atlantic water to below average in October the inflow was intensified The waters near the bottom in this area were found to have a salinity of 34 87–34 88 per mille and the authors assumed that they are related to the East Iceland Arctic Current and flow from west to east It was pointed out by Mr O Sælen (Norway) that these salinity values are lower than the standard values for Norwegian Sea bottom water Dr J B Tait (Britain) pointed out that the water might have been Arctic Intermediate Water In reply to a question, Prof J V Preobragenski (U S S R) said that the salinities had been determined by the Knudsen titration method At this stage Prof G Dietrich (Federal Republic of Germany) stressed that the results collected during the Polar Front Survey should be sent to the International Council for the Exploration of the Sea as well as World Data Centres *A* and *B* Mr Sælen described Norwegian work in the same area in 1958, in March and October an intensification of the inflow of Atlantic water in the latter month was noted, as had been reported by the Russian workers A special feature observed was the ascent of cold water along the continental slope off Norway. Finally, Dr J Eggvin (Norway) presented a series of temperature, salinity and current charts for the Norwegian and Greenland Seas, and showed how the Norwegian Sea bottom water is formed in the region north of the Jan Mayen Ridge in some years and not in others, depending on the meteorological conditions, and how this bottom water flows southwards from the Greenland Sea along the foot of the Norwegian continental slope towards the Faroe–Iceland Ridge It was further shown that the temperature of the bottom water of the Greenland Sea increased in temperature northwards from the main area where it is formed This temperature increase is a result of mixing with Atlantic water The positive difference between the temperature of the bottom water of the Arctic Ocean and that of the Greenland Sea can therefore be explained without, as previously, assuming a submarine ridge (1,200–1,500 m) between Spitsbergen and the north-eastern part of Greenland This is of interest in view of the recent work of Dr. L Balakshin (U S S R), who by investigations on board ice-breakers has shown that the sill depth between the Greenland Sea and the Arctic Ocean exceeds 3,000 m In discussion of this paper it was pointed out that the sinking of water to form the bottom water might set up a system of compensatory surface currents which would be of importance to the Barents Sea fisheries

Shetland–Faroe–Iceland Region Dr J B Tait and Mr J H A Martin (Britain) had computed the volume transport through the Faroe–Shetland Channel over the period of the International Geophysical Year and found it to be high at the beginning and end but low at other times Gulf of Gibraltar water seems to have been present in the oceanic water-mass in June 1957 and June 1958 In June 1957 the inflow was cut into two parts by Arctic Intermediate Water which was moving southwards, and in June 1958 it was similarly divided by a southerly flow of Norwegian Sea water Overspill of cold Norwegian Sea water was noted along the Faroe–Iceland Ridge in June 1957 and March 1958 but not at other times

On the basis of surveys made along the Faroe–Iceland Ridge during 1957–58, Dr J H Steele (Britain) had come to the conclusion that overflow of very cold (0–2° C) water is rare and unimportant, but that there is continuous overflow of a slightly warmer

(2–4° C) water which is the product of mixing of water masses of Atlantic and Arctic types on the top of the ridge This overflow has a geostrophic motion north-westwards along the southern side of the ridge, and it then turns southwards along the eastern side of the Reykjanes Ridge The total flow over the ridge is calculated as being near the mean value of the Faroe–Shetland inflow A discussion of this paper by Prof Dietrich showed that, on about 50 per cent of the surveys of the ridge, overflow of cold (0–2° C) water has been found The relative importance of overflow directly across the ridge and outflow through the channel between Faroe and Faroe Bank was debated by Dr Tait, Mr F Hermann (Denmark) and Dr Carruthers

North Atlantic Ocean Prof Dietrich described various stages in the evolution of the International Geophysical Year and considered the next stage the exploitation of the observations He suggested the preparation of an atlas of maps and sections of the North Atlantic Using German observations, he demonstrated the existence of six water masses on the Cape Farewell–Flemish Cap section In particular, he examined the origin of the North Atlantic deep water in the Labrador Basin and the overflow of cold water across the Iceland–Greenland Ridge, and showed how the latter could be tracked over a great distance clinging to the lower part of the continental slope and not flowing along the very bottom of the basin He also showed how the winter surface isotherms are a guide to the circulation of the North Atlantic in that season.

A paper was given by Dr W Krauss (Federal Republic of Germany) showing that internal waves can be set up in the deep layers of the ocean as well as in the upper layers by the action of the wind

From dissolved oxygen/potential temperature diagrams, Dr L H N Cooper (Britain) concluded that the water column in the Bay of Biscay consists of a layered series of resident water masses resembling a pile of plates stacked one on the other He regarded these plates as being the result of the overspill of boluses of cold water across the Faroe–Iceland Ridge He also demonstrated a secular change in dissolved oxygen content since 1922 It was pointed out by Prof Dietrich that the stepwise structure described could also be explained by Dr Cooper's earlier turbidity current theory, and that this structure had not been as yet found in other areas where very detailed hydrographic observations had been made (for example, south-west of Iceland) The dating of the climatic fluctuation which had brought about the secular change in dissolved oxygen content was discussed by Mr Lee and Dr Cooper

French observations in the North Atlantic and Davis Strait were described by M G Peluchon (France) Charts of the currents in the region of 50° N showed the meandering of the current as it leaves the Grand Banks area and a decrease in the meanders as the current proceeds eastwards

Dr J Joseph (Federal Republic of Germany) described his work with a transparency meter combined with a thermocouple The turbidity distribution depends on local production on one hand and advective processes and turbulence on the other Connexions between the turbidity sections and the temperature sections could be seen He also showed that there is no change in turbidity at the deep scattering layer In discussion a strong case was made for fish as being the cause of this layer

Dr H Weidemann (Federal Republic of Germany) described work with towed electrodes (*GEK*) between Greenland and Iceland At a fixed station south of Iceland the records collected over a period of 30 hr allowed the relation between wind and surface current to be investigated The results gave a mean deflexion of current to the right of the wind of 27° and a current/wind ratio of 1 4–1 5 per cent The difference between these values and Ekman's theoretical values can be explained by assuming that conditions were non-stationary

Mr F Hermann described Danish observations in the North Atlantic in July–August 1958 West of the Reykjanes Ridge the basin was largely filled with sub-arctic mixed water, as already described by Prof Dietrich Cold water coming over the Iceland–Greenland Ridge was again found on the bottom in the western part of the Irminger Sea East of the Reykjanes Ridge a bottom layer with a temperature below 3° C was found, consisting of mixed water derived partly from overflow across the Faroe–Iceland Ridge, partly from Atlantic water and partly from sub-arctic water This water circulated anti-clockwise around the basin and crossed the Reykjanes Ridge to flow north on its westward side and mix with the overflow across the Iceland–Greenland Ridge In the Davis Strait water which had overflowed the Greenland–Baffin Island Ridge but which does not contribute to the North Atlantic circulation as a whole was detected

Dr R A Cox (Britain) gave an account of the work of R R S *Discovery II* A section showing the distribution of silicate along lat 24° N had three outstanding features the depletion of silicate but not of phosphate at the surface in the Sargasso Sea, the high silicate content of the bottom water of Antarctic origin west of the mid-Atlantic Ridge, and the very irregular bottom topography Work with Swallow's neutrally buoyant floats west of Portugal showed how even in the deep ocean there are great variations in current speed and direction The outflow of Mediterranean water from the Straits of Gibraltar had also been tracked by these floats, and it was shown that a westward movement of 12 nautical miles/day could exist close to the Spanish coast, but that farther south there were large eddies Dr Cooper pointed out that the silicate distribution along lat 24° N showed that Antarctic bottom water must make a contribution to the bottom waters east of the mid-Atlantic Ridge, and Prof T Braarud (Norway) did not think that the silicate deficiency prevented phytoplankton production in the Sargasso Sea The phosphate budget of the Mediterranean Sea was discussed by several speakers Mr Sælen then described Norwegian work carried out in collaboration with R R S *Discovery II* west of Portugal Current measurements from an anchored ship allowed the tidal streams to be analysed, they were present to the bottom (760 m) and showed no decrease in velocity with depth, but there were indications of some differences in the direction of rotation The residual current, however, decreased with depth

Prof N Menendez (Spain) gave an account of temperature and salinity conditions along the meridian of Tarifa in August 1958 Sections were worked at different states of the tide and the distributions found could only be explained in terms of changing mixing conditions depending on the strength of the tidal streams

Mr L V Worthington and Mr W G Metcalf (U S A) examined the salinity/potential temperature relationship in the North Atlantic deep water using the very precise salinity data that have now become available with the development of conductimetric techniques A salinity/potential temperature curve for the western North Atlantic below the 4° C potential isotherm has been established and its shape accounted for in terms of water masses Departures from this curve in different parts of the Atlantic can be used as indicators of water movement The outstanding features shown by this form of analysis were the formation of the newest Atlantic deep water in the Labrador Basin, the part played by the South-East Newfoundland Ridge in preventing the Antarctic bottom water from reaching the Labrador Basin, the water of the Norwegian Sea origin on the eastern slope of the mid-Atlantic Ridge, the outflow and spreading of Mediterranean water, and the fact that the western basin of the South Atlantic is the source of the deep cold water found in the rest of the Atlantic, communication to the eastern basin being through the Romanche Trench

A paper by Mr J R Lumby (U S A) read by Dr Tait showed that there were large differences in the dissolved oxygen values at comparable stations worked by American, British and Russian ships during the International Geophysical Year Mr Worthington said that such differences could depend to some extent on the type of water-bottle used, and on the method of standardization of the sodium thiosulphate solution used for titrating the samples

Baltic and North Seas In a paper on the southern Baltic Sea, Dr A Majewski (Poland) showed that the inflow of oceanic water had decreased since 1951–52 and that, at the end of 1958, the salinity in the Baltic basins had reached its lowest level since 1952 The year 1958 had been a cold one so far as the Baltic was concerned Similarly, in a paper on the North Sea by Dr J Filarski (Poland), read by title, the winter and spring of 1958 were shown to have been cold, but by the autumn of 1958 there were positive anomalies of temperature Dr V V Betin and Prof J V Preobragenski (U S S R) submitted a paper which was read by title on ice research in the Baltic during the International Geophysical Year Aircraft were used to make synoptic surveys of ice conditions The curves of accumulated temperature, ice extension and ice accretion so produced were found to be related

Biology

Prof E Steemann Nielsen (Denmark) presided over the biological session

Productivity Three papers were presented The first was by Mr Grim Berge (Norway) on the productivity of the Norwegian Sea using, besides carbon-14 measurements, an estimate of productive capacity, derived from measurements of transparency A continuously recording transparency meter was described It was shown that in 1958 the quantity of production as measured by 'productive capacity' was different from that in 1954 In reply to a question as to whether there was a correlation between productive capacity and standing stock, Mr Berge replied that there was, but that the relationship was different in different water masses Prof Braarud commented on the marked changes noticed from year to year and their apparent relation to hydrographic processes

Mr Vagn Hansen and Prof E Steemann Nielsen described carbon-14 measurements and chlorophyll measurements in the North Atlantic and in the Greenland Sea Mr Hansen showed that from Cape Farewell to Ireland greater counts of carbon-14 were obtained towards Greenland and above the Reykjanes Ridge This was associated with greater quantities of chlorophyll Prof Steemann Nielsen demonstrated the relationship between carbon-14 counts and quantities of chlorophyll *a*, which was biased by the possible presence of dead chlorophyll Mr G Murphy (U S A) asked whether transparency might not be a better method of measuring productivity if the constants in the equation were known Prof Steemann Nielsen replied that this would be a good method in oceanic waters, but in coastal waters the quantity of inorganic material was high Dr M Gillbricht (Federal Republic of Germany) pointed out that only one-third of the turbidity in the Irminger Sea was due to plankton Mr Berge said that the quantity of inorganic particles ordinarily was constant and so the variations due to production differences could be estimated

Biophysics and Biochemistry Dr H Schaefer (Federal Republic of Germany) described the distribution of amino-acids in redfish (*Sebastes*) and certain other fish for a number of stations at sea It was shown that the variation in relative composition of certain amino-acids was much greater than that which might have been expected from studies in freshwater fish Mr Murphy noted that a similar result had appeared in the work on the Californian sardine

Plankton Dr K F Wiborg (Norway) described the distribution of zooplankton in the Norwegian Sea He noticed that the distribution of reverberation on the echo-sounders at full gain corresponded fairly well with the distribution of euphausiids and fish fry The distribution of copepodite stages bore some relation to hydrographical conditions In response to a question, Dr Wiborg said that smaller fish have smaller eggs and spawn later

Drs E A Pawstiks and L N Grutzov (U S S R) presented a paper on the distribution of plankton in the Norwegian Sea This distribution corresponded reasonably well with that presented by Dr Wiborg

Dr J H Fraser (Britain) described indicator species in the Faroe–Iceland Ridge region and from the presence or absence of certain long-lived animals concluded that the International Geophysical Year was not a normal year Mr Lee pointed out that during the first eight months of 1958 the Polar Front lay well to the south, presumably holding back the northward flow of Atlantic water

Dr Gillbricht gave a detailed account of the distribution of phytoplankton, zooplankton and organic particles on a section between Newfoundland and the Azores Counts were made from small water samples of 0 3 ml for phytoplankton and of 5 ml for zooplankton By converting all quantities to total carbon and comparing these with phytoplankton, he was able to distinguish three water masses Prof Steemann Nielsen asked whether the organic particles were artefacts, because if the same technique is used in Danish waters many organic particles were derived from the destruction of phytoplankton Dr H Einarsson (Iceland) noticed that the quantity of zooplankton collected with Hardy indicators in the Irminger Sea was roughly similar to that collected with a 5-ml water sample in the same area

Mr J Corlett (Britain) described the zooplankton collected at weather stations *I* and *J* and showed that the total quantities were greater in 1958 than in 1957 Mr Hansen noticed that *Evadne nordmanni* had also been found in the Norwegian Sea. Dr Fraser said that *Thalia democratica* found by the Plankton Expedition in 1888 off west Scottish coasts appeared for the first time off west Scottish coasts in 1958

Dr W Hohnck (Federal Republic of Germany) presented an interesting paper on the quantity and types of fungi in the sea and on the sea bed The majority of samples taken showed development of hyphæ

Fisheries Dr Eggvin presented a paper by Mr L Midttun on echo-surveys in the Barents Sea In general, there was a relationship between the distribution of echo-traces and isotherms in the Barents Sea

Conclusions There appeared to be two main conclusions from the biological papers

(1) The International Geophysical Year differed in two respects from some other years, in indicator species and in quantity of living material

(2) Three advances in productivity studies were revealed (*a*) the use of transparency as an index of productivity under certain limited conditions, (*b*) the fairly close relationship between standing stock (as chlorophyll) and productivity (as carbon-14 count), (*c*) the use of very small samples of phytoplankton (0 3 ml) and zooplankton (5 ml) to give sensible estimates of carbon in living material

A J Lee
D H Cushing

EFFECTS OF FOREST AREAS ON WATER RESOURCES, AND THE TECHNIQUE OF LYSIMETRY

BETWEEN September 8 and 13, two symposia were held in Germany by the International Association of Scientific Hydrology, at Hannoversch-Munden, where the Forestry School of the University of Gottingen is established

One symposium concerned the influence of wooded areas on the elements of the water balance Thirty-five papers were presented, ten from the U S S R , eight from the United States, four from Great Britain, two each from Finland and Poland and one each from the Belgian Congo, Czechoslovakia, Denmark, French Africa, Germany, Holland, Hungary, South Africa and Switzerland

The other symposium dealt with the technique of lysimetry and the causes of error in results obtained There were seventeen papers, four from the United States, three from Holland, two each from the Belgian Congo, Germany and the U S S R , and one each from Austria, France, Hungary and Great Britain

The papers were made available in printed form at the meeting and have since been placed on sale by the Association* Most of them are written in English, and the few others in French or German

The symposia were attended by more than a hundred hydrologists, from other countries as well as from those which contributed papers There was naturally a strong German representation, while both the United States and Great Britain had important teams It was regretted that, while the U S S R had sent several valuable papers, their authors were not present to introduce them

Below is given an appreciation of each of the two symposia and of a two-day visit paid afterwards to German field-stations concerned with one or other of the two subjects that had been discussed

It is expected that the discussions of the papers will be reported briefly in the quarterly issues of the Association's *Bulletin*, the price of which is 150 Belgian francs yearly

Water and Woodlands

In many countries, increasing concern with the provision and maintenance of adequate water supplies in the face of continuously increasing demands has stimulated considerable interest in the scientific management of this most vital of our natural resources With fuller appreciation of the importance of form of land use in catchment areas, much attention has naturally been directed to the role of a forest cover Compared with other countries such as the United States and Germany, Britain is a rather late entrant into this field, but within recent years, the problem has come very much to the fore and there can be no doubt, especially in view of the recent drought, that we shall have to devote very much more attention to this important issue As elsewhere, differences of opinion exist as to whether, from the hydrological point of view, our catchments are better under forest than, say, under pasture The answer is by no means as clear-cut as some would make out, the hydrological relationships involved are most complicated and objective quantitative assessments beset with considerable practical difficulties It was therefore most timely that under the auspices of the International Association of Scientific Hydrology much of the experience and present knowledge in this field could be surveyed and discussed

Almost half the contributions were concerned with investigations on the catchment scale In principle, these involve the measurement of precipitation and run-off (both surface and subsoil), normally by stream gauging, despite the substantial cost of installation and maintenance, and, very often, difficulties in ensuring absence of leaks and a reasonable standard of precision, this approach is still essential for the provision of the basic hydrological data appropriate to the problem as a whole As an alternative to the 'straightforward' comparison, say, between forested and non-forested catchments, Idson (U S S R) preferred continuous measurements on an area under the influence of a varying forest cover Because of the well-known difficulties in ensuring comparability between catchments, this latter approach would generally seem to be the more reliable one, the regression techniques used by Idson and by Anderson and Hobba (U S A), in which run-off is related to the various meteorological, soil or land-use factors which influence run-off, offer an approach which allows for a more complete interpretation of the complex relationships involved

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* Publication No 48 (Vol 1 Water and Woodlands) Pp 340 300 Belgian francs Publication No 49 (Vol 2 Lysimeters) Pp 169 150 Belgian francs Obtainable from Mr Arthur F Bird, 66 Chandos Place, London, W C 2, or the Secretary of the International Association of Scientific Hydrology, Prof L J Tison, 61 Rue des Ronces, Gentbrugge, Belgium

In those countries where snow forms an important source of water there was general agreement as to the beneficial influence of a forest cover, the data of Anderson and Hobba (U S A), Goodell (U S A), Martinelli (U S A) and Sozykin (U S S R) clearly showed that through accumulation and the shelter provided, the forest retards thawing, reduces the danger of spring floods and prolongs the supply of melt water The difficulties of measuring snowfall and the need for further investigation were made clear in the papers of Martinelli (U S A) and Sepannen (Finland)

General recognition was also given to the higher permeability and greater storage capacities of soils developed under forest, leading to reduced surface run-off, less erosion and a more prolonged yield of water during drought Anderson and Hobba (U S A), Valek (Czechoslovakia) and Banky (Hungary), among others, clearly demonstrated the regulatory effect of the forest on stream flow, Rodier (French West Africa) showed that flood peaks were 8–12 times lower from forest than from savannah, and the importance of this effect was recognized by Wicht in his published recommendations for the management of catchment areas in South Africa

So far as absolute quantities were concerned, most contributors were prepared to accept a somewhat lower yield from a forested area as compared with areas under other vegetative covers Meginnis (U S A) provided one of the more extreme examples from the classical Coweeta experiments in North Carolina, where clear cutting of mountain hardwood forest increased the annual yield by 11–17 in and cutting of the shrubby understory by 2 in To conserve water in the south-western United States, Horton recommended the clearance of phreatophytes (vegetation with permanent access to ground water) along streams and rivers While such losses from forest stands were generally attributed to higher levels of transpiration, usually because of deeper rooting and access to water during dry periods, some would attempt to explain at least some of the losses to interception of precipitation by the foliage Thus, Eidmann (Germany) stated that because it intercepts appreciably less rainfall, a beech forest conserves more water than a spruce forest The implied assumption that intercepted water means a corresponding loss to the soil was contested by Leyton and Carlisle (Great Britain), who produced experimental evidence indicating, as might be expected, a marked fall in transpiration following wetting of the foliage, attention was also directed to the possibility of rather large errors in the estimation of through-fall in a stand using a limited number of gauges, and the increase in accuracy obtainable when these were replaced by troughs with larger collecting areas The papers of Bochkov and certain other Russian contributors provided an interesting contrast to the generally prevailing opinion that a forest cover means a lower yield of water These authors argued that, because of deep ground-water movement in forest soils, the gauging of small streams draining small catchments may under-estimate the yield and that over large areas, in certain cases at least, yield from the forest may be even higher than that from open land. Sokolovsky (U S S R) also claimed that an increased water loss from forest by transpiration may be balanced by reduced evaporation from the soil It is possible, therefore, that even in the case of water yield, final judgment on the effect of a forest cover may have to be postponed, from the point of view of energy relations, at least, one would not expect large differences in the loss of water from different types of vegetative cover

A number of contributors described other means of investigating quantitatively the hydrological relations of a site Visser (Holland) explained his soil moisture flow approach, which provides an estimate of the water balance from measurements of rainfall, potential evaporation and the ground-water level in the soil and in ditches, Lebedev (U S S R) also provided an interesting analysis of ground-water dynamics under forest and grass covers From measurements of water loss from detached shoots of Scots pine, Rutter (Great Britain) gave evidence of transpiration values apparently exceeding Penman's estimate of E_T (potential evaporation from grass), this, combined with his observations that the trees continued transpiring even down to a soil moisture deficit of 7 in or more, introduces still further problems in our interpretation of forest hydrological relationships As yet another approach to the estimation of water losses from forest stands, Leyton (Great Britain) discussed the possibility of measuring the volume rate of sap flow in tree stems by the heat-pulse method originally introduced by Huber It was regretted that, apart from a few words in discussion by Baumgartner (Germany), there was no opportunity to learn of the present status regarding the energy-balance approach

In summarizing one's general reaction to the papers reported above and to the subsequent discussions, one cannot but be impressed by the magnitude of the efforts made to gain a better understanding of the hydrological relationships of the forest At the same time it is evident that much still remains to be done So many aspects have to be considered and so many factors are involved that it is usually not possible to extrapolate findings from one area to another, in this respect the use of regression analysis to define certain underlying relationships has a very promising future It is also clear that most countries do not look at the forest simply as a potential drain on water supplies, to be avoided wherever possible As H C Storey, director of the U S Forest Service Division of Watershed Management Research, pointed out, the emphasis must be on the multiple use of the forest, Lambor (Poland) echoed the same theme in his recommendations for a water economy plan based on the proper appreciation of the comprehensive role of a forest cover

Following the symposium, an excursion was made to various forest catchment experiments in the area Eidmann (Dusseldorf) demonstrated two of his seven stream-gauge installations set up in small catchments to investigate the influence of various types of forest cover and of forest practice, primarily on water yield, at Lahnhof, beech and spruce forest are being compared and at Helgersdorf, coppice and high forest The Ruhrtalsperrenverein, the organization largely responsible for supplying water to the Ruhr industries, has nine similar installations, two of which, on the Runkhauserbach (99 per cent forest) and the Konigswasser (97 per cent arable), were also inspected

Coming from a country with similar water problems, but without a single catchment experiment designed specifically to investigate forest influences, one is greatly impressed by the enthusiasm with which these problems are being tackled in Germany. It is not difficult to criticize many of these installations; precipitation measurements, stream-gauge design, the possibility of leaks and questionable comparability of catchments, all raise problems which could readily intimidate the ultra-cautious particularly in view of the costs involved. Nevertheless, with the example set by the Americans, Germans and other nationals, and with access to their knowledge and experience, can we in Britain afford not to set up similar experiments of our own? L. LEYTON

Lysimeters

A lysimeter is an apparatus used for measuring the quantity or quality of water which has percolated through a container which is filled with soil or similar material. It is easy to see that, within such a definition, lysimeters can be used for such a variety of specific purposes that each installation must be considered on its own merits; an ever-present danger is to interpret what is measured by means of the lysimeter as being representative of any conditions other than those obtaining in the lysimeter itself.

Lysimeters are commonly installed to throw light on what happens in the field, where many different factors affect the amount of percolated water. The position is essentially similar to that encountered in measuring temperature, rainfall and other meteorological factors, where, however, arbitrary standards of measurement have been accepted for purposes of making comparisons between values obtained at different sites. So far, standard conditions have not been accepted for lysimeter installations and readings, and indeed comparatively few suggestions have been put forward for standardization of observations.

It is thus not surprising that several of the papers read at the symposium described lysimeters which could throw some light on what happened, with the passage of time, only in particular circumstances. Various ingenious and, in some cases, expensive installations have been set up, in which care has been taken to avoid such things as disturbance of the natural soil profile, or of the homogeneity of the vegetation cover. But in almost none were there lacking unmeasured variables which, even though in some cases a correlation with adjoining field conditions could satisfactorily be established, allowed of any trustworthy comparison between one site and another.

W. C. Visser, of the Netherlands, was one of those who read papers pointing out that conditions in a lysimeter are essentially artificial, and that the factors introduced by this artificiality need to be measured or eliminated. Visser particularly recommended water-flow potential measurements in the field to 'calibrate' the lysimeter measurements; this involves measuring ground-water depth, tension in the capillary zone, tensions in the plants, and vapour pressures in the air. K. Ubell, of Hungary, placed emphasis on the need to have constant records of the temperature gradients in the field and in the lysimeter. Harrold and Dreibelbis, in describing some of the work at the well-known installations at Coshocton, Ohio, showed themselves vividly aware of difficulties, which have failed to be understood by some who have quoted the Coshocton results too uncritically.

Lysimeters can broadly be divided into those measuring volume and those measuring weight. There is much to be said for the latter, because not only do they help to overcome the problem of changes in the amount of water stored in the lysimeter, but they also enable changes to be recorded as continuously as is desired; lysimeters working on volumes of outflow water necessarily have by contrast a much more considerable time-lag. Several speakers, however, pointed out that weighing lysimeters were not the complete answer which some had incautiously considered them to be; for example, one is not sure whether what is being weighed at one season is strictly comparable to that being weighed at another time of the year.

E. J. Winter (Great Britain) read a joint paper by P. J. Salter, G. Stanhill and himself describing the installations at the National Vegetable Research Station in Warwickshire. Besides directing attention to some interesting and significant results which need further investigation, he stressed that much satisfactory and adequate practical advice can now be given to growers, even though more research is needed to elucidate the mechanisms of, and variations in, the water balance.

G. F. Makkink, in describing the various installations in the Netherlands, made the following useful summary remark: "It is considered the final aim of lysimeter research to gain an insight into the water balance of any natural soil-profile as a function of climate, vegetation and movement of the ground water. This aim widely surpasses the limited scope of the lysimeter observation of the separate institutions who own them". The recognition of this has led to appreciable progress in the Netherlands in co-ordinating results.

Several speakers, particularly G. L. Dupriez (Belgian Congo) and F. H. W. Green (Great Britain), emphasized the value of first obtaining observations of potential evapo-transpiration, under 'standard' conditions, at a network of stations. Cheap oil-drum lysimeters were found to be quite adequate for this purpose, if both sited and handled under comparable conditions. Green pointed out that, by simple subtraction, one could get reasonably reliable values of the seasonal differences in 'water deficit' and 'water surplus' from station to station, even where the absolute values of potential evapo-transpiration and of rainfall were open to doubt. In this connexion, several speakers emphasized the difference between the rainfall measured in rain-gauges at the standard height and that falling on the ground. In both Britain and Germany this seemed to be of the order of rather more than 5 per cent; ground-level gauges are therefore installed at most German lysimeter stations.

One of two week-end excursions at the end of the symposium was devoted primarily to visiting lysimeter installations. The first of these visited was in the Senne heathlands, near Bielefeld, and was operated in connexion with the water undertaking of that town. It consisted of four weighing lysimeters, one metre square cross-section, filled (in three cases) with 'monolith' blocks from three different soil profiles found in the area (the fourth was a 'disturbed' block from one of the areas). None of these lysimeters was irrigated, so that, particularly in a dry year like 1959, the lysimeters could supply facts but not explanations.

The second place visited was to an ingenious forest installation at Bossendorf, near Haltern, in Westphalia. Here, in addition to a more orthodox lysimeter in an adjoining arable field, were two batteries of four lysimeters each, one under a stand of conifers and one under a stand of broad-leaved trees These had been made by pressing large rain-gauge-shaped lysimeters upwards into the soil under the trees, from a horizontal gallery, painstakingly excavated to avoid disturbance of the natural conditions The aim was limited to measuring differences in rates of recharge of soil-water, but they have not been operating long enough for the results to be assessed

The third visit was to the installation of the Dortmund Waterworks at Geisecke on the Ruhr Here there are batteries of (*a*) volume lysimeters, and (*b*) weighing lysimeters, filled with different materials and with different vegetation covers Although undoubtedly useful information is obtained, the results from type (*a*) might be queried in view of the very large amount of bare concrete surrounding the tanks, while in both types (*a*) and (*b*) reasonable homogeneity with the surrounding vegetation was achieved only in certain of the tanks In fact, the series of records from each of these lysimeters, as at some other installations, could be considered only separately, and not safely compared with those from any of the others

F. W GREEN

OBITUARIES

Prof. H. J. Backer

HILMAR JOHANNES BACKER was born at Dordrecht on January 13, 1882, and died at Glimmen, near Groningen, on April 29, 1959 He was a pupil at the Gymnasium in Dordrecht and studied at the University of Leyden under Franchimont in chemistry and H A Lorentz in physics His doctoral thesis was entitled "De Nitraminen en hunne Electro-chemische Reductie" He also worked with Elbs at Giessen on the technique of electrochemical reduction and later in the Davy Faraday Laboratories at the Royal Institution in London After two to three years on the staff at Leyden and a similar period in industry and in Government service, he was called to the chair of organic chemistry at Groningen in 1916 as successor to J F Eykman His colleague, Dr J Strating, said that Backer soon showed his capacity for hard work, for concentration and for utilizing every free moment, and yet it seemed that the passage of years only increased his broad humanity

A survey of his researches (1905–55) reveals an increasing occupation with compounds containing the $-SO_2-$ group This can be correlated with the early work of Franchimont on α-sulphopropionic acid which Backer and Franchimont resolved in 1914 by means of strychnine Backer then prepared and resolved α-chloro- and α-bromo-sulphoacetic acids, α-seleninopropionic acid, α-sulphobutyric acid, several α-arsenocarboxylic acids and also chlorobromoacetic acid

About 1930 he began a study with Strating of the unsaturated cyclic sulphones formed from sulphur dioxide and butadienes The close relation of these compounds to the thiophens led to a study of the oxidation of thiophen homologues in the hope of obtaining the corresponding sulphones Thiophen itself, on oxidation, gives a 'sesquioxide', presumably formed by 1 4-addition between the unstable sulphoxide and sulphone of thiophen It was found that certain dialkyl- and diphenyl-thiophens gave sulphones on oxidation, tetraphenylthiophen had long been known to do so This was attributed to the presence of the substituents which increased the electron availability on the sulphur atom In some cases a sesquioxide was formed On the other hand, electron-attracting groups in the benzene nucleus of 3 · 4-diphenylthiophen inhibited sulphone formation

In 1952 Backer began to study imenes of the type $(R\,SO_2)_2C{=}C{=}NR'$, which are very reactive Three of these have recently been submitted to X-ray analysis by Wheatley, Bullough and Daly in Leeds with very interesting results

At the beginning of the occupation of the Netherlands in 1940, Backer gave much help and advice to his students, whose whole world had suddenly fallen to pieces He kept in touch with all those who were forcibly deported to Germany, sent them parcels and encouraged and advised their parents. When I visited Backer in 1947, he referred only briefly to his imprisonment in 1945 and said nothing of the physical violence which he endured during interrogation The other occupant of his cell was shot The liberation of Groningen probably saved Backer from the same fate

Later on, two of my research students visited Groningen at Backer's invitation, lived in his house for some weeks and worked in his Department Dr A Ash wrote "It was his habit to have students lodging with him and he liked nothing better than for students to call in the evening for a short talk; help or advice were gladly given He interested himself also in their social life He methodically inquired of his students' progress every morning and imparted an impressive practical technique particularly rich in devices for facilitating manipulation of small quantities" Dr A G Lowther has said "One's immediate impression on meeting him was that here was a man who demanded one's respect and affection This was not only a first impression—it was there among his students—they had a real affection, almost love, for Prof Backer He never appeared to be hurried, was most courteous and had a quiet, but real, sense of humour I never heard one word of criticism of him there was a serenity about him and his house"

Dr Strating wrote "Nothing could prevent him from helping a friend or a student who was in need, and this, no doubt, led to his arrest" Backer was a knight of the Order of the Netherlands Lion, a member of the Royal Academy of Sciences in Amsterdam, a correspondent of the Paris Academy of Sciences and an honorary member of the Solvay Institute in Brussels He received honorary doctorates from the Universities of Ghent and Lille

When those who knew him recall Backer's achievements as a man and as a chemist, his great capacity for friendship and for hard work, his fearlessness and his quiet mind, they feel that he went far towards solving happily the eternal problem, *si jeunesse savait, si vieillesse pouvait*

FREDERICK CHALLENGER

Prof. E. S. Salmon

AFTER a long illness, Prof. Ernest Stanley Salmon died on October 12 at the age of eighty-eight.

Anyone unfamiliar with mycology might be pardoned for thinking that his reputation rested on the breeding of new varieties of the hop (*Humulus lupulus* L.). Yet when he came to Wye College (University of London) in 1906, he had already established himself as the authority on an important group of fungi. Researches at the Jodrell Laboratory, Kew, had led to the publication, in 1900, of "A Monograph of the Erysiphaceae", a work which remains fundamental for systematic mycology and which was reproduced as microcards only a few months ago. After further study in the laboratory of Prof. Marshall Ward at Cambridge, he demonstrated the very highly developed specialization of parasitism in the same group; accounts of this may be found in the *Transactions of the Royal Society*, 1904 and 1905.

Salmon was appointed to Wye College to study diseases of plants and so was probably the first professional plant pathologist in Britain. There were then few helpful text-books, but it was not long before he had combined laboratory work and field experiments to good purpose. His first papers, which may even now be read with profit, describe in some detail a selection of the diseases of crop plants; the main emphasis being on apple scab (*Venturia inaequalis* (Cooke) Wint.) and other pathogens of fruit. Bordeaux mixture and lime sulphur, fungicides which are still in use, were introduced to Kentish orchards, while he conducted a vigorous campaign in the Press and elsewhere which led to the passing of the Destructive Insects and Pests Act in 1907.

He was elected president of the British Mycological Society in 1911; appointed reader in economic mycology in the University of London in 1912, professor of mycology in 1925 and emeritus professor in 1939. He was made Fellow of Wye College in 1948.

When, soon after the First World War, the specialist advisory service in Britain began, he was appointed advisory mycologist of the Wye Province. Until he relinquished this appointment in 1937, he led a series of investigations on diverse plant diseases. Particularly noteworthy are the contributions on fruit and hops with which are associated his colleagues, Drs. H. Wormald and W. M. Ware.

Salmon arranged a programme of hop breeding in 1907 and followed this without a break until his last illness. From the beginning, one of his main aims was to produce varieties with exceptionally high preservative values; such varieties would enable the British grower to compete with imported American hops. In order to have at command a wide range of diverse types, he assembled male and female plants from different parts of the world; this unique collection, together with selected progeny, for long occupied about an acre of ground at Wye College. Of the many thousands of seedlings raised, his earliest success was the English-grown American, Brewer's Gold. This was $F1$ from an English male hop and a wild hop from Morden, Manitoba. Paradoxically, the variety has been more widely grown in Canada and the United States than in Britain. The varieties Bullion and Northern Brewer which have become so popular with the British hop industry during the past decade are $F1$ and $F3$ seedlings, respectively, of parents from the same sources. Other seedlings of his raising proved to be tolerant to hop wilt (*Verticillium albo-atrum* Reinke and Berth.) and these have been of great value for planting in infected soil.

In recognition of his work on hops he received in 1955 the Horace Brown Medal, the highest honour which the Institute of Brewing can bestow.

After the manner of the pioneer, Salmon was a strong individualist and, in his later years at least, showed little enthusiasm for gatherings, whether scientific or social. He found relaxation in literature and in his small garden of rare plants.

H. H. GLASSCOCK

Prof. J. Zenneck

PROF. JONATHAN ZENNECK, one of the earliest pioneers of radio science, died in Munich in April, a few days before his eighty-eighth birthday. Prof. Zenneck was born in 1871 in Württemberg, Germany, and studied mathematics and natural science at Tübingen, where he obtained his doctorate in 1894. In the following year he became an assistant in the Physical Institute in Strasburg; he moved to Dantzig in 1905 to become assistant professor, and later (1911) professor of physics in the Institute of Technology. His academic career was continued by his appointment in 1913 to the chair of physics at the Technical High School of Munich, where he remained until his retirement.

Most of the basic contributions of Prof. Zenneck were made in the days when spark transmitters were used for wireless telegraphy, concurrently with the development of high-frequency machines and arc generators to produce undamped oscillations for radio-telephony. Among the earliest of his achievements was the establishment of the first radio-link for navigational purposes between Cuxhaven and Heligoland in 1899–1900. His basic experimental and theoretical contributions to wave propagation were of great importance in the early development of wireless communications. He expounded the first theory on wave propagation along the Earth (Zenneck wave) which explained the effect of the ground constants on polarization and absorption of the waves. Also well known are his basic contributions to ionospheric research, which he initiated in Germany; and he was the founder of the first German ionospheric research station, Herzogstand, in Kochel, Bavaria, which was in operation until 1945.

Dr. Zenneck's interests were not limited to radio. He also contributed to other areas in the general field of applied physics such as acoustics and gas discharges. He was the author of the first German text-book on wireless telegraphy, "Electromagnetic Oscillations and Wireless Telegraphy", published in 1906, which was the classic work in this field for many years. He was also the editor of the *Hochfrequenztechnik und Elektroakustik*, the leading journal of the world during the early days of radio.

His second book, entitled "Wireless Telegraphy", was published in Germany in 1908, and a second edition appeared four years later. It was translated into English in 1915 by A. E. Seelig, and published in London and New York, forming one of the most useful text-books available to students at that time on the generation, propagation and detection of electromagnetic waves in the radio part of the spectrum.

He received many honours and medals from academic and professional societies, including an honorary doctor's degree from the Institute of Technology at Dresden He was made a fellow of the Institute of Radio Engineers (N Y) in 1915, received its medal of honour in 1928, and was a member of the board of directors and vice-president in 1933 He was honorary president of the German National Committee of the International Scientific Radio Union, and was elected vice-president of that Committee in 1938 All those who had the pleasure of meeting Prof Zenneck at international conferences will remember his charming personality and his modest simplicity, combined with wittiness and quickness of repartee.

R L SMITH-ROSE

NEWS and VIEWS

Nobel Prize for Physics for 1959 :

Dr Emilio Segre and Dr Owen Chamberlain

Dr Segre and Dr Chamberlain, who have been awarded the Nobel Prize for Physics for 1959, have collaborated in research in high-energy physics for a number of years at the Lawrence Radiation Laboratory of the University of California at Berkeley Dr Segre was born in Italy in 1905 and was a member of Fermi's remarkable nuclear research school in Rome He emigrated to the United States before the War Dr Chamberlain is thirty-nine and, like Dr Segre, is a distinguished experimentalist Their collaboration at Berkeley has been associated with the great accelerators which have been built there over the years They were the leading members of a team engaged in experiments on nucleon-nuclear interaction with the help of the 184-in synchrocyclotron, and in particular made a detailed study of polarization phenomena in high-energy scattering The work which has now been honoured by the Nobel award has, however, been their discovery in 1955 of the antiproton in experiments with the 6 GeV -proton synchrotron, the bevatron The existence of the antiproton had been confidently postulated for many years , the discovery of the positron in 1932, and its interpretation on the Dirac theory, also implied the existence of other anti-particles including a negatively charged proton Antiprotons stubbornly eluded discovery in the very high-energy (but very low-intensity) bombardments of cosmic radiation, and one reason for building the bevatron was to have an intense beam of sufficiently energetic protons to create proton–antiproton pairs in the laboratory

The actual discovery, however, involved a long series of painstaking experiments with very elaborate detection equipment which had to be specially developed The development of effective techniques for beam separation and detection for use with machines of very great energy is a field of research in itself The antiprotons produced when a beam of high-energy protons falls upon a target in a machine like the bevatron are very greatly outnumbered by other charged particles produced with very broad momentum spectra in the relativistic region These background particles would cause impossible confusion in the detection apparatus if they were not systematically eliminated Their elimination in the experiments of Segre and Chamberlain was a major programme in experimental physics The final apparatus used was elaborate and refined Charge and momentum separation of antiprotons from the mixed beam of particles was achieved by magnetic deflexion and focusing in separate lenses, and velocity selection was aided by time-of-flight and Čerenkov radiation techniques When some forty events had been accumulated which corresponded within acceptable margins of error with the properties of the antiproton, it could be said that the antiproton had been discovered As is usual in high-energy research with large machines, team-work by large numbers of physicists and engineers was involved , the award of the Nobel prize to Segre and Chamberlain underlines the fact that the brilliant individual worker is still needed to inspire and direct the work

Royal Society Medals for 1959

THE following awards of medals have been made by the President and the Council of the Royal Society *Copley Medal* to Sir Macfarlane Burnet, director of the Walter and Eliza Hall Institute, Melbourne, Australia, for his distinguished contributions to knowledge of viruses and of immunology *Davy Medal* to Prof R B Woodward, of the Department of Chemistry, Harvard University, Cambridge, Massachusetts, for his distinguished researches in organic chemistry and particularly for his contributions to the structure and synthesis of natural products *Hughes Medal* to Dr A B Pippard, reader in physics in the University of Cambridge, for his distinguished contributions in the field of low-temperature physics

Genetics at Cambridge : Prof J M Thoday

A GRADUATE of the University College of North Wales, Bangor, Dr J M Thoday, who has recently been appointed to the Arthur Balfour chair of genetics in Cambridge, began his research career in the Botany School, Cambridge, under the guidance of Dr (now Prof) D G Catcheside These early studies of the action of ionizing radiations on chromosome structure were interrupted by war service in the Royal Air Force, to be resumed after the War at the Mount Vernon Hospital and Radium Institute, where, in collaboration with Dr J Read, Thoday demonstrated the effect of oxygen tension on the frequencies of chromosome changes following irradiation During 1947 he moved to Sheffield to take up an appointment as lecturer in cytogenetics, becoming senior lecturer in charge of the newly founded Department of Genetics there in 1954 In Sheffield his research moved towards the field of population genetics, particularly in relation to the genetical control of stability in development and to the action of disruptive selection His experiments with *Drosophila* have been especially rewarding in the light they have thrown on the power of disruptive selection to conserve variability and to build up polymorphisms within populations They are showing us for the first time under controlled conditions how polymorphisms can come into being and how their genetical structure reflects the selection which has brought them about Prof Thoday's breadth of experience and originality of approach augur well for the future of genetics in Cambridge

Genetics at Sheffield : Dr J A Roper

DR J A ROPER returns to his own University (Sheffield) as the first holder of the new chair of genetics. Dr. Roper graduated in chemistry at Sheffield in 1945, and was trained in bacterial biochemistry under Krebs and McIlwain. He joined the Genetics Department at Glasgow in 1948 and played a very important part in the development of that school of genetics. For his ability as a teacher, and his engaging personality, he is well liked by the students. At Glasgow he introduced, with great success, group discussion methods. Dr. Roper was Rockefeller Fellow in 1953 at the California Institute of Technology, and has lectured at various times in a number of American and European universities. He is secretary of the Genetical Society.

Dr. Roper's training in chemistry and microbial biochemistry was a good foundation for the research in microbial genetics on which he embarked at Glasgow. He played a major part there in a team working on the genetics of *Aspergillus nidulans*. A most decisive contribution was the first deliberate search for, and his demonstration of, what could be called the 'splitting of the gene' (*Nature*, 166, 956; 1950). Soon after he designed a way of synthesizing heterozygous diploid strains in filamentous fungi. This was the first step which made possible the discovery of the 'parasexual' cycle and the development of genetic analysis *via* mitotic segregation. In the past three years Dr. Roper has become interested in investigating extra-nuclear inheritance in *Aspergillus*. Dr. Roper's ability in teaching and research will be given full opportunities in this new chair, born in a most favourable environment.

The Animal Health Trust

H.M. the Queen has graciously consented to become patron of the Animal Health Trust. The Trust was founded by Dr. W. R. Wooldridge in 1942 for the purpose of improving the general health standards of all types of domesticated animals, and it approaches the task in two ways: First, by means of scientific investigation of the many disease problems of such animals; secondly, by stimulating the flow of trained personnel into the ranks of the veterinary profession through financial grants to needy students and by furthering the higher education and specialization of veterinary graduates. Four research centres have been established by the Trust for the study of disease in horses, dogs, poultry and farm animals, respectively, the latest of which—the Farm Livestock Research Centre at Stock, Essex—was opened by H.R.H. Prince Philip in December 1957 (see *Nature*, 181, 76; 1958). A new surgical unit to mark the patronage of the Queen is to be built at the Equine Research Station, Newmarket, at a cost of about £30,000.

The Office of the Lord Privy Seal

With the appointment of Lord Hailsham as the Minister with general responsibility for science and technology, including atomic energy, the Atomic Energy Office and the Lord President's Office will be combined. The new Office will be in the charge of Mr. F. F. Turnbull, whose appointment as deputy secretary, to succeed Sir Friston How in charge of the Atomic Energy Office, was announced some months ago. It will be organized in two Divisions: (1) a General Division, under Mr. R. N. Quirk, under-secretary, corresponding to the previous Lord President's Office; and (2) an Atomic Energy Division, under Mr. M. I. Michaels, under-secretary, corresponding to the previous Atomic Energy Office.

Parliamentary Responsibility for Science and Technology

The Prime Minister made a statement in the House of Commons on October 30 regarding the responsibilities of the Lord Privy Seal and the Minister for Science, stating that other Ministers would remain responsible for the scientific establishments within their own Departments, but that the Minister for Science was to be responsible for broad questions of scientific policy outside the sphere of defence, and was advised by the Advisory Council on Scientific Policy on general questions which relate to the whole field of civil science. On November 3, Mr. Macmillan indicated that the arrangements for answering questions in the House of Commons which fall within the responsibility of the Minister for Science would be as follows: questions about the Medical Research Council and radiobiological hazards, the Minister of Health; Agricultural Research Council and Nature Conservancy, the Minister of Agriculture; nuclear energy, the Department of Scientific and Industrial Research and general scientific matters, the Minister of Education; space research, the Minister of Aviation. Where questions about the development of nuclear energy relate to matters for which some other Minister is responsible, that Minister would answer them. For example, questions about nuclear-powered merchant shipping would normally be answered by the Minister of Transport, and about nuclear power stations by the Minister of Power. Mr. Macmillan had earlier defended the exclusion of the new Minister of Power from the Cabinet, but neither that arrangement nor those for answering questions for the Minister of Science in the House of Commons were well received.

Scientific Developments in Britain

Replying to a question in the House of Commons on November 2, Mr. J. B. Godber, as representing the Lord Privy Seal, said that a small temporary station is to be established near Cambridge to expand the work already being done at the Low Temperature Research Station and elsewhere, and he hoped it would be in operation by the end of next year. Meanwhile, the Agricultural Research Council is considering the wider issues raised by the proposal to establish a permanent centre for meat research. In a written answer on November 5, the Minister of Education, Sir David Eccles, as representing the Minister for Science, stated that the new Hydrodynamics Laboratory of the National Physical Laboratory had cost about £2 million, and its staff was nearly 70, including 10 scientific officers. The Laboratory would provide up-to-date facilities for testing ship designs, particularly in reproducing more realistic sea conditions, and research would be conducted to extend basic knowledge of the resistance, propulsion and sea-going qualities of ships, while new ship designs would be tested for industry.

In a written reply to a further question on November 5, Sir David Eccles said that commissioning trials of the fast reactor at Dounreay had proved more difficult than expected, due to chemical engineering problems, but enriched uranium is now being loaded and the reactor is expected to become critical within the next few weeks. This reactor, he said, is an experiment in the development of fast breeder systems, and successful exploitation will depend upon the operating results: the development of the fast reactor will occupy the resources of the Dounreay establishment for many years. The Admiralty submarine reactor development programme at Dounreay is now getting under way, and firms in the north of Scotland with the necessary scientific and technical experience would be given the opportunity of tendering for any development work which could be let out to industry.

Inauguration of *Merlin*

WHEN H.R.H. the Duke of Edinburgh formally inaugurated *Merlin*, the nuclear research reactor built by Associated Electrical Industries Ltd. (see *Nature*, September 5, p. 11) at Aldermaston on November 6, an underwater closed-circuit television camera specially designed by E.M.I. Electronics Ltd. made possible the observation of activity inside the reactor. This camera, which is 30 in. long, 3½ in. in diameter, and enclosed in a pure aluminium water-tight housing, is a permanent part of the equipment of *Merlin*. In addition, a standard E.M.I. camera has been mounted above the reactor, on the second floor of the reactor hall. This provides a continuous view all around *Merlin*, and ensures that no unauthorized staff are near the reactor when it is in use. Two 14-in. receivers, one for each camera, have been rack-mounted in the control room on the ground floor and another receiver has been installed on the second floor for observation inside the reactor. A 17-in. console receiver, capable of selecting a picture from either camera, has been installed in the reactor conference room. Three more E.M.I. cameras and seven more receivers were used at the opening ceremony to give the audience an uninterrupted view of the proceedings from the moment the Duke of Edinburgh entered the reactor hall on the ground floor, while he was inspecting the top of *Merlin* from the second floor, and upon his return to the ground floor to start the reactor and unveil a commemorative plaque.

Joint British Committee for Vacuum Science and Technology

FOLLOWING the Institute of Physics' London Conference on high vacua held in April last, various suggestions were made for arranging regular meetings in Britain on vacuum science and technology, and for British participation in international conferences in this field. As a result of informal discussions, a Joint British Committee for Vacuum Science and Technology has now been formed. The Committee consists of representatives from each of the following bodies: Institute of Biology, Institution of Chemical Engineers, Royal Institute of Chemistry, Institution of Electrical Engineers, Iron and Steel Institute, Institution of Mechanical Engineers, Institute of Metals, Institute of Petroleum, Physical Society and Institute of Physics. Its objects are (*a*) to co-ordinate and help to initiate meetings in the whole field of vacuum science and technology arranged by constituent bodies; and (*b*) to act in the collective interest of the constituent bodies by maintaining liaison with the International Organization for Vacuum Science and Technology and with national vacuum societies, and otherwise. The Institute of Physics has agreed to provide the secretariat for the joint committee; communications should be addressed to the Secretary of the Joint British Committee at 47 Belgrave Square, London, S.W.1.

Scientific Policy in South Africa

THE first and second annual reports of the Advisory Council on Scientific Policy of the Union of South Africa cover the periods December 1956–December 31, 1957 (pp. 5) and January 1–December 31, 1958 (pp. 7), respectively (Pretoria: Advisory Council on Scientific Policy, 1958 and 1959). The Council, which has nine members, including Prof. H. O. Monnig as chairman, was appointed late in 1956 to enquire into and report on all matters referred to the Council by the Minister of Economic Affairs. It is required to acquaint itself with scientific developments and policy in other countries and to advise the Minister concerning any action necessary in South Africa; to take note of all international scientific conferences and make recommendations regarding representatives; and to investigate cases of overlapping of research and other activities referred to the Council by the Minister and make recommendations as to responsibility for the work.

In its first report the Advisory Council, attributing the shortage of scientists and technologists fundamentally to weaknesses in secondary education, recommended that the Government should increase both funds and facilities available for training scientists at the universities, as well as actively promote the training of technologists and improve the salaries and conditions of employment of scientists. A survey of the country's requirements for scientists and technologists by the Research Bureau of the Department of Education, Arts and Science was also recommended, and the Council's consideration of the condition and organization of research issued in a recommendation for the appointment by the Government of a commission to investigate the organization of agricultural research and the establishment of an independent Agricultural Research Council. The Advisory Council does not consider its responsibility regarding attendance at international conferences can be satisfactorily discharged under the present arrangements or that the set-up permits adequate access in general to Cabinet level.

In its second report the Advisory Council recommends the compilation and maintenance by the National Bureau for Educational Research of a National Register of Scientists and Technologists. Some consideration was given to the relation between the Council for Scientific and Industrial Research and the universities, and at the request of the South African Chemical Manufacturers' Union the Council considered the desirability of Government support for research on the processing of agricultural products, but concluded that the proposal was undesirable and that developments in this field should be left with the Council for Scientific and Industrial Research. An inquiry into overlapping of State-aided research, requested by the Treasury, led to the recommendation that the Government Metallurgical Laboratory should become an institute of the Council for Scientific and Industrial Research. A Cabinet Committee has been appointed to investigate the shortage of man-power in science and means of reducing this shortage, and a commission is investigating the desirability of an independent Agricultural Research Council, but otherwise no action appears to have been taken on the recommendations suggested in the first report.

Inland Telegraph Service

THE Committee appointed during December 1957, under the chairmanship of Sir Leonard Sinclair, "to advise the Postmaster-General on the future place of the inland public telegraph service as part of the communication facilities of the United Kingdom", does not consider that, subject to keeping under review the extended use of the telephone for sending telegrams over the shorter distances, further integration of telegraphs with telephones, as recommended by the Bridgeman Committee of 1932, would be justified at present, though there may be scope for further integration with the telephone service or possibly with the telex service later The number of telegrams has steadily declined from 53 3 millions in 1947–48 to 18 7 millions in 1956–57 and an estimated 16 9 millions in 1957–58, and the loss per telegram has risen from 14 2*d* to 40 3*d* in 1956–57 and 48 2*d* in 1957–58 This is mainly due to the relatively small gap in the communications facilities of the United Kingdom filled by the service and this gap is being reduced in size by other Post Office services Foreign administrators face a similar problem and the traffic is expected to continue to decline Although the service is only of marginal importance to business establishments and only occasionally used by the public for social purposes, in its report the Committee recommends retention of the service to handle a proportion of overseas and emergency telegrams and for other reasons (Report of the Advisory Committee on the Inland Telegraph Service, 1958 Pp iii+11 London H M Stationery Office, 1958 1*s* net) Increase of the tariff is recommended and the new structure should be one of a basic charge plus a charge for every word The Post Office, it is suggested, should consider the elimination or reduction of the deficits due to Press traffic and telegrams to the Irish Republic and should arrange to charge the British Transport Commission with the cost of Railway Pass telegrams

Meldola Award

It is announced that the next award of the Meldola Medal will be made early in 1960 to the chemist who, being a British subject and under thirty years of age at December 31, 1959, shows the most promise as indicated by his or her published chemical work brought to the notice of the Council of the Royal Institute of Chemistry before December 31 The merits of the work may be brought to the notice of the Council, either by persons who desire to recommend the candidate or by the candidate himself, by letter addressed to the President, Royal Institute of Chemistry, 30 Russell Square, London, W C 1, from whom further information can be obtained

Royal Society of Edinburgh . Officers for 1959-60

At the annual statutory meeting of the Royal Society of Edinburgh the following officers and members of Council were elected *President* Prof E L Hirst, Department of Chemistry, University of Edinburgh *Vice-Presidents* Dr D P Cuthbertson, Mr A W Young, Prof T Neville George, Prof J R Matthews, Dr T R Bolam, Dr Douglas Guthrie *General Secretary* Prof Norman Feather, Department of Natural Philosophy, University of Edinburgh *Secretaries to Ordinary Meetings* Dr A W Greenwood and Dr Mowbray Ritchie *Treasurer* Dr J R Peddie *Curator* Dr R Schlapp *Councillors* Prof A M MacBeath, Prof R A Rankin, Prof A E Ritchie, Prof V C Wynne-Edwards, Prof E G Cullwick, Prof G Pontecorvo, Prof M M Swann, Prof H A Bruck, Prof T S Westoll, Dr H R Fletcher, Prof G L Montgomery, Prof W L Weipers

Announcements

The Minister for Transport and Power for the Republic of Ireland has appointed Mr J Connor, of the Department of Transport and Power, to be chairman of the National Committee for Geodesy and Geophysics in succession to Mr A Ó Coinneain

Mr R Levin has been appointed development planning executive at Aspro-Nicholas, Ltd , of Slough, Bucks Mr Levin was formerly chief pharmacist, Research and Development Division, and lately manager of the Technical Information Department of the Distillers Co (Biochemicals), Ltd He is the author of "The Pharmacy of Silicones and their Uses in Medicine"

Following the resignation of Dr C. E Dalgliesh as secretary of the Biochemical Society, Dr P N Campbell, Courtauld Institute of Biochemistry, Middlesex Hospital, London, becomes secretary to the Committee, and Dr W J Whelan, Lister Institute, Chelsea Bridge Road, London, S W 1, has been appointed meetings secretary

The National Collection of Industrial Bacteria has been transferred from the National Chemical Laboratory to the Torry Research Station (Department of Scientific and Industrial Research) All future inquiries and correspondence concerning the Collection should be addressed to the Curator, National Collection of Industrial Bacteria, Torry Research Station, Aberdeen

A symposium on hæmatology has been organized by the University of Cambridge Post-Graduate Medical School, and will be held during December 7–9 Further information can be obtained from the Secretary, Medical School, Tennis Court Road, Cambridge

The U S Office of Naval Research has announced that the second Conference on Semiconductor Surfaces will be held at the U S Naval Ordnance Laboratory, White Oak, during December 3–4 Further information can be obtained from the chairman of the Steering Committee, Dr J N Zemel, U S Naval Ordnance Laboratory, White Oak, Silver Spring, Md

The Indian Society of Theoretical and Applied Mechanics has announced the Fifth Congress on Theoretical and Applied Mechanics, to be held at the University of Roorkee during December 23–26 Further information can be obtained from the Secretary-Treasurer, Indian Society of Theoretical and Applied Mechanics, Institute of Technology, Kharagpur, India

The autumn general meeting of the British Iron and Steel Institute will be held in London during December 2–3 The sessions, some of which will run simultaneously, will be held in the Great Hall, Caxton Hall, S W 1, and in the Hoare Memorial Hall, Church House, S W 1 Further information can be obtained from Mr K Headlam-Morley, Iron and Steel Institute, 4 Grosvenor Gardens, London, S W 1 All applications must be returned by November 27

Erratum In the article entitled "Transmission of a Virus to Strawberry Plants by a Nematode (*Xiphinema* sp)" in *Nature* of September 26, p 962, line 5 in par 2 should not have been inserted The phrase should read " the causal virus of yellow crinkle and of mosaic was transmitted by mechanical inoculation from plants of a number of strawberry varieties, including "

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

COMMISSION ON GEOCHEMISTRY

THE Commission on Geochemistry of the International Union of Pure and Applied Chemistry held a meeting in Munich during August 26–27, during the twentieth Conference of the Union Attending the meeting were the following members of the Commission Prof T F W Barth (*president*), Dr F M Vokes (*acting secretary*), Prof C Burri, Prof C W Correns, Prof S I Tomkeieff, Prof L R Wager, Prof F E Wickman and three observers of the Commission Prof A P Vinogradov, Prof K Sugawara and Prof E Ingerson

The Commission discussed at length its future objects and aims, particularly with regard to the work of its sub-committees The chairmen of the three existing sub-committees reported on their activities, these comprise the subcommittee on abstracting, translation and information, the sub-committee on the chemistry of the oceans and the sub-committee on rock analyses It was decided to broaden the scope and work of the Commission by forming sub-committees on "the organic compounds in the crust of the Earth" and "the beginning of the biosphere"

It was also considered highly desirable that some form of code should be compiled which could be used to indicate the exact analytical methods which had been employed in mineral and rock analyses reported in publications It was decided to seek the co-operation of the Sections of Inorganic and Analytical Chemistry of the Union to further this end The question of education and training for geochemistry was also discussed at some length In particular, it was agreed that the education committee of the Geochemistry Society should be encouraged to produce a definitive report on this subject as a basis for further discussion

The subject of future symposia on geochemistry came in for a considerable amount of discussion It was decided to offer the Commission's co-operation in respect of the proposed symposium of the International Union of Geodesy and Geophysics to be held in Helsinki in July 1960, and that of the Geochemical Society to be held in Copenhagen in August 1960 For the Copenhagen symposium it was suggested that the Commission should be responsible for organizing a section of the geochemistry of sedimentary carbonate rocks

Prof A P Vinogradov of the Vernadsky Institute of Moscow gave the members present a short summary of the current geochemical work being carried out at the Institute He also mentioned that discussions were taking place regarding the formation of a Russian geochemical society which he hoped would in time be able fully to co-operate with similar bodies outside Russia Prof K Sugawara also gave a short account of the position and activities of the Japanese Geochemical Society

Election of Members In order to replace those members due to retire at the end of the present year, the following were elected members of the Commission Prof L H Ahrens, Prof E Ingerson, Prof K Sugawara and Prof A P Vinogradov The officers elected for the session beginning 1960 were *President*, Prof C W Correns (Gottingen), *Vice-President*, Prof A P Vinogradov (Moscow), and *Secretary*, Prof E Ingerson (Austin, Texas) In addition, it was decided to invite seven new observers to serve with the Commission The president-elect, Prof Correns, proposed a vote of thanks to the retiring president, Prof Barth, for his work for the Commission during his term of office and this was carried with acclamation

SCIENCE AND PHILOSOPHY

THE fourth annual conference of the British Society for the Philosophy of Science was held during September 25–27 at Newnham College, Cambridge, and was attended by about eighty members and guests Dr M B Hesse was conference secretary

Four symposia were held "Scientific Research and the Philosophy of Science", "Biology and Physics", "Classification, Concept-formation and Language", and "Knowing and Being"

At the first session, with Dr J O Wisdom in the chair, it was argued whether 'philosophy of science' can be held to refer to any activity not properly subsumed under 'scientific research', and, if it can, whether that activity is relevant to research Prof H Dingle mentioned various questions of value and purpose, as well as of method, papers on which were unlikely to be accepted for publication in journals concerned with particular sciences Prof H C Longuet-Higgins, on the other hand, argued that, of the product of philosophers of science, part was science, part was philosophy, and the remainder was of no use to man or scientist This aroused some consternation, as members consulted their own credentials and invoked those of others, but in due course a consensus emerged that scientists have to think critically about their thinking, and the comparative study of modes of scientific thought may help them to do so

In the second session, Prof J H Woodger described an abstractive hierarchy of terms characterized by a one–many relation, and its use as a conceptual framework in biology With some hierarchies of cells, every cell is a distinct life, with others, only the first cell in each hierarchy, elaboration occurring on subsequent levels Morphology was the study of the arrangement and differentiation of parts, physiology was the study of the existential dependence of parts Genetics was concerned with the process in which the first member of a hierarchy results from the conjunction of two members of other hierarchies Dr E M Hutten set alongside this framework the sequence exhibited by radioactive decay each new atom produced was similarly time-extended, stemmed from a parent atom, and consisted of existentially dependent parts, but it was not dependent on its environment analogously to a cell In elementary-particle theory, explanation might amount to little more than classification, or an enumeration of possibilities, and might have little more predictive power than comparable biological models with their over-determination and multiple-causation The chairman, Prof C F A Pantin, referred to the occurrence, in biology, of morphological models that can be interpreted at more than one level in an organizational hierarchy In discussion it was suggested that the predictive power of a theory might not always be manifest at the time of its original formulation, it might have to await development of deduction There was much interest in the relative importance of the past history of an entity in biology and in physics historical existential dependence appears to be a function of complexity

In the third session, with Mr G Buchdahl in the chair, Miss M Masterman and Mr R M Needham presented the strategy, and some of the tactics, of a method of analysing language by assimilating it to a library classification system in which concepts are arranged on a finite lattice ordered by a single, weak, 'concordance' (inclusion) relation They further suggested that the formation of scientific concepts is a development of language according to this model There was some discussion as to whether the method is a technology for mechanical translation, or a science, or a philosophy of language, and it was suggested that it could be viewed as a scientific model of language, containing the partly uninterpreted concept 'inclusion', and capable of being tested by experiments on translation and on analogy-finding

In the fourth session, under the chairmanship of of Dr W H Thorpe, Prof M Polanyi presented a way of talking about the primary process of knowing by perception, the pre-articulate act of knowing, which partakes of the uniqueness of the individual percipient, the unspecifiable personal knowledge from which any specifiable, potentially public, knowledge is derived by a process of abstraction Complex entities were commonly perceived and recognized as wholes before particulars had been identified; the process of discovery, in fact, might be regarded as an alternation of analysis, recognizing particulars, and integration, recognizing the relations of parts to the whole Prof R B Braithwaite suggested that too narrow a view might be taken of specifiability, and that some levels of subjective experience, however vague, could be conveyed by language—for example, 'Oblomov' conveys the experience of laziness, beyond that, he differed from Prof Polanyi in his use of the term 'knowledge' for what was unspecifiable In the subsequent discussion there was some reluctance to focus on this rather undemocratic mode of tacit awareness, and a preference for talking about what can be made public, with the implication that the progressive refinement of scientific language tends to eliminate the unspecifiable

In conclusion, it is perhaps worth directing attention to the unusualness of a scientific conference at which speakers are not armed with specified and verifiable data but attend primarily to make as explicit as possible how they think, and to receive criticism of the process thereby revealed, especially from those who are not working in the same field The coherence of this universe of discourse was illustrated by the frequency of reference from one discussion to another, the *esprit d'escalier* from one session often finding its outlet in a later one, its range, by the frequency of spontaneous quotation, not only from Shakespeare and Wordsworth but also from Swinburne (and early Swinburne, at that). G E Denyer

FOURTEENTH ANNUAL CALORIMETRY CONFERENCE

THE fourteenth annual Calorimetry Conference, held at Yale University in the Sterling Chemistry Laboratory during September 10–12, was attended by more than one hundred scientists from the United States, Canada and Europe Under the chairmanship of Dr David White (Ohio State University) thirty papers were read and discussed These included heat capacity measurements at temperatures as low as 0 1° K and as high as 1,400° K, precision reaction and bomb calorimetry, solution calorimetry, and determinations of stored energy in solids

Most of the papers were concerned with recent developments in calorimetry However, as calorimetric techniques are extended to more extreme conditions, the problems that led to the founding of the Conference remain under new guises The need for better temperature measuring devices was emphasized in seven papers that reported on research at temperatures below 11° K No device comparable to the platinum resistance thermometer, now in general use for measurements above 11° K, is yet available for the very low temperatures at which some of the most important calorimetric research is now being done However, the reports on a device that may extend precision thermometry to at least 1° K, namely, the germanium resistance thermometer developed in the Bell Telephone Laboratories, were received enthusiastically Twelve of these thermometers had been provided for a calorimetry conference test programme involving eleven different laboratories Three papers at the Yale conference described the first results of the investigations, which were so promising that the Conference plans to seek a manufacturer of additional units for a more extensive testing programme

Special addresses were given by Profs George S. Parks (Stanford University) and Lars Onsager (Yale University) At the annual banquet, Parks delivered the Hugh M Huffman Memorial Lecture, "Some Remarks on the Thermodynamic Properties of Organic Compounds" Parks and one of his first graduate students, the late Dr Huffman, started the first systematic calorimetric studies of organic compounds at Stanford more than thirty years ago Enlivening his remarks with many personal anecdotes, Parks traced the history of thermodynamic research on organic substances and the role improvement of calorimetric methods has taken in the remarkable progress made in the past three decades Prof Onsager gave the principal lecture of the technical sessions on "Co-operative Phenomena", a field in which he has developed much of the basic theory Many papers at each Calorimetry Conference describe experimental studies of co-operative phenomena, and Onsager outlined the approaches one may take in seeking a theoretical understanding of such effects Admitting that three-dimensional treatments of critical phenomena by statistical mechanics seem hopelessly complex, he dwelt mostly on more simplified treatments that give results

In addition to the objective of promoting better calorimetric research, the Conference also is concerned with publication policies relating to calorimetric and thermodynamic articles A "Resolution regarding Published Calorimetric Data" adopted by the eighth Conference in 1953 has proved to be valuable to editors and authors alike in establishing consistent policies based on the opinions of experts in the field Because calorimetric research has expanded into many areas not covered by the 1953 resolution, the fourteenth Conference established a committee headed by J P McCullough to consider revising and extending the earlier recommendations Drs Edgar F Westrum Jun (University of Michigan), and Stig Sunner (University of Lund, Sweden) presented a proposal of the Commission on Thermodynamics of the International Union of Pure and Applied Chemistry for a joint meeting in 1961 of the Calorimetry Conference and the Subcommissions on Experimental Thermochemistry and Experimental Thermodynamics The Conference unanimously approved the proposal for a joint meeting to be held either before or after the biennial meeting of the Union that year in Montreal, Canada Plans will begin immediately for what should be one of the most important conferences ever held in the field of calorimetry

At the annual election the following members were appointed to Conference offices *Chairman*, Dr J P McCullough (Petroleum Thermodynamics Laboratory, Bureau of Mines), *Chairman-Elect*, Dr D W Osborne (Argonne National Laboratory), *Directors*, 1959–62, Dr N E Phillips (University of California, Berkeley) and Dr J M Sturtevant (Yale University) Other officers include *Secretary-Treasurer*, Dr C E Messer (Tufts University) and *Directors*, Dr David White, Dr D H Andrews (Johns Hopkins University), Dr J E Kunzler (Bell Telephone Laboratories), and Dr. J A Morrison (National Research Council, Ottawa)

SECOND AUSTRALIAN SPECTROSCOPY CONFERENCE

THE second Australian Spectroscopy Conference, convened by Dr A L G Rees (Division of Chemical Physics, Commonwealth Scientific and Industrial Research Organization) and held in the Chemistry Department of the University of Melbourne during June 1–3, was opened by Prof J S Anderson, who welcomed the 110 participants and the four exhibitors of commercial spectroscopic equipment The first session of the conference was devoted to ultra-violet spectra and began with a review by Prof N S Bayliss (Chemistry Department, University of Western Australia) of recent theoretical work on solvent effects He directed attention to the calculations of Polansky on the interaction between two H atoms which predict a red shift in the atomic spectrum beyond a critical distance and a blue shift at closer distances, to the calculations by Longuet-Higgins and Pople of the red shift in the spectra of non-polar solutes in non-polar solvents arising from dispersive forces, and to McRae's formulations of the case of polar solute and polar solvent The McRae formula predicts a frequency shift between absorption and fluorescence arising from the change of dipole moment between the ground and excited states, thus providing a method for measuring the dipole moments of excited states for comparison with calculated values

One set of contributed papers in this section dealt with the spectra of aromatic hydrocarbons Drs G R Hunt and I G Ross (Physical Chemistry Department, University of Sydney) discussed a vibrational analysis of the 7000 A and 3500 A absorption systems of azulene which appears to confirm the predictions of Pariser and of Moffitt concerning the nature of the excited states Dr L E Lyons and Mr G C Morris (Physical Chemistry Department, University of Sydney) presented results on the absorption of anthracene vapour (38,000 to 60,000 cm^{-1}) They confirmed the second π–π transition as allowed and also observed four members of a Rydberg series converging to an ionization potential of 6 81 eV Dr N S Ham (Division of Chemical Physics, Commonwealth Scientific and Industrial Research Organization) reported some calculations by the free-electron model, with electronic interaction, of the spectrum of the perinaphthenylium cation $C_{13}H_9{}^+$, which agree well with the reported spectrum and also predict an unreported absorption band at about 600μ

Studies by Dr I G Ross and E J Wells (Physical Chemistry Department, University of Sydney) on the interesting tetrahedral molecules OsO_4 and RuO_4 failed to reproduce the extensive fine structure reported in the room temperature spectra by Langseth and Qviller in 1934 The authors gave a vibrational analysis of their spectra and used the energy-level scheme of Ballhausen and Liehr to assign the two allowed transitions A theoretical paper by Dr E G McRae (Division of Chemical Physics, Commonwealth Scientific and Industrial Research Organization) was concerned with electronically excited states of aggregated identical molecules, the intra-molecular vibrations were explicitly included Two limiting cases were recognized, depending on whether the interaction energy was large or small with respect to the vibrational energy An interpretation of the *J* band of N,N′-diethyl-pseudo-cyanine was offered on the basis of this theory

Dr H A. McKenzie (Division of Food Preservation and Transport, Commonwealth Scientific and Industrial Research Organization) spoke on the difference spectra in acid solutions and in urea solutions of bovine serum albumin, ovalbumin and conalbumin

Dr L E Lyons (Physical Chemistry Department, University of Sydney), in opening the session on solid state spectroscopy, described a number of the effects observed in ionic solids and semi-conductors Such effects include structure in the absorption edge of the conduction band, hydrogen-like absorption series due to excitons, the high intensity of the conduction band absorption of germanium due to the low effective mass of the electrons, intervalence band transitions in germanium, and the magnetic splitting of the conduction-levels in InSb The use of cyclotron resonance in determining the presence of excitons and in evaluating effective masses was also noted Crystal field effects in the spectra of inorganic complexes and the Davydov splitting in molecular crystals were also discussed

Dr J A Friend (Chemistry Department, University of Tasmania) and Dr Lyons have identified two transitions in the crystal spectrum of sodium nitrate, an allowed one at 2000 A and a weak n-π transition at 2870 A Dr J Ferguson (Division of Chemical Physics, Commonwealth Scientific and Industrial Research Organization) has analysed the polarized spectra of microcrystals of some cobalt (II) tetrahedral and octahedral complexes The absorption spectra of the tetrahedral complexes of the type $CoPy_2X_2$ are modified by intermolecular interaction in the crystal while the octahedral complexes can be interpreted by simple crystal field theory Mr J E A Alderson (Physics Department, University of Western Australia) discussed the luminescence spectra of thallium-doped potassium iodide in the spectrum range 600 A to 2500 A recorded on a normal incidence grating spectrometer with a photomultiplier as detector Dr L E Lyons, Dr J R Walsh and Mr J W White (Physical Chemistry Department, University of Sydney) presented the polarized visible spectrum of single crystals of phthalocyanine An attempt was made to calculate the crystal spectrum using the Davydov theory, but the error in estimating the dipole vector is too large to allow an unambiguous assignment of the crystal levels

Two papers on vacuum spectroscopic technique were presented One by Mr R S Crisp (Physics Department, University of Western Australia) described a grazing incidence, photon-counting grating spectrometer, working in the range 40–1000 A It has been found that the soft X-ray band emission spectra obtained with this instrument change with the material of the grating (aluminium to glass), with time, and with the order in which the grating is used These effects have no explanation at the moment J V Sullivan (Division of Chemical Physics, Commonwealth Scientific and Industrial Research Organization) described a double-beam photoelectric 1 m grating spectrometer, which has been tested down to 1500 A The monochromator employs a concave grating in a new type of mounting in which deviations from the Rowland circle lead to no detectable loss in resolution The double-beam system involves grazing incidence reflexion to split the exit beam and two electronically coupled photo-multipliers to record the spectra Examples of spectra recorded over the range 1500–6000 A were presented

The second day of the conference began with a review of some of the infra-red, Raman and microwave work of 1958 by Prof A N Hambly (Canberra University College) Topics discussed included accurate determination of molecular geometries from gaseous Raman and microwave spectra , information on torsional modes barrier heights, barrier tunnelling and rotational isomerism from spectra in the cæsium iodide and microwave regions , pressure-induced transitions in gases Perturbation effects and solvent effects need further study, for the reviewer pointed out that despite considerable work on the subject, the intensities of infra-red bands in polar solvents still do not accord with the theories

In a research paper Prof Hambly and J G Allpress (Chemistry Department, University of Melbourne) showed that infra-red spectra can be used to follow some solid state reactions They illustrated their remarks by showing spectra of the products of reaction between U_3O_8 and alkali or alkaline-earth halides They could detect differences that were not discernible in X-ray powder patterns

Dr E Spinner (Australian National University, Canberra) discussed the vibration spectra and structure of the hydrochlorides of urea, thiourea and acetamide Infra-red and Raman spectra suggest that the cations are formed by the addition of a proton to the nitrogen rather than to the oxygen atom and that the C—N bond in an amide is a pure single bond Drs N S Ham and J B Willis (Division of Chemical Physics, Commonwealth Scientific and Industrial Research Organization) dealt with the infra-red and Raman spectra of some isothiocyanates They have identified the symmetrical NCS stretching frequency in $—CH_2NCS$ types at about 670 cm.$^{-1}$, and at about 930 cm $^{-1}$ in aromatic —NCS compounds They also gave a detailed interpretation of the complex structure of the strong NCS characteristic band near 2100 cm $^{-1}$ A J Costoulas (Department of Chemistry, University of New South Wales) gave a complete vibrational assignment for methyl-isothiocyanate He agreed with Ham and Willis in the reassignment of the band at 676 cm $^{-1}$ to the symmetrical NCS stretching frequency

Prof A N Hambly and R H Laby (Chemistry Department, University of Melbourne) discussed some criteria for allocating displacements of X—H bond stretching frequencies to the formation of hydrogen bonds These are a double absorption band for weak intermolecular H-bonds and most weak intramolecular H-bonds, a double absorption band at low concentration in non-polar solvents for stronger intermolecular H-bonds, and a large displacement of frequency but no doubling on dilution for strong intramolecular H-bonds Some exceptions were illustrated by the spectra of some ortho-amino acetophenones and anthranilic esters The stable conformations of a series of methyl-*cyclo*-hexanols were reported by Dr A R H Cole and G T A Muller (Chemistry Department, University of Western Australia) Small but significant differences in the stretching frequencies of axial (3627–32 cm $^{-1}$) and equatorial (3622 5–23 cm $^{-1}$) hydroxyl groups were used to determine the conformations The methyl group was found to have a greater tendency to be equatorial than the hydroxyl group A G Moritz (Department of Organic Chemistry, University of Adelaide) has examined the overall appearance of the 3000 cm $^{-1}$ region in the infra-red spectra of a number of methyl-substituted polycyclic hydrocarbons He has confirmed the general applicability of the correlation between the pattern of this region and the free valence number of the position of substitution in the parent hydrocarbon, a correlation first observed by Fuson and Josien for the methyl-1 2-benzanthracenes

The results of a normal co-ordinate analysis of the 33 planar vibrations of naphthalene were presented by D E Freeman and Dr I G Ross (Physical

Chemistry Department, University of Sydney) An iterative procedure of adjusting the force constants was used to force agreement with seven of the frequencies the assignment of which is most certain This necessitates some reassignments, and the resultant interpretation is in general agreement with the work of Luther

The simplest molecule discussed at the conference was hydrogen deuteride the weak dipole vibration spectrum of which was the subject of a paper by Dr R A Durie (Coal Research Station, Commonwealth Scientific and Industrial Research Organization) The internuclear distance and the anharmonicity constants were calculated from measurements of the rotational structure of the (1,0), (2,0), and (3,0) vibration bands Dr D W Posener (Division of Electrotechnology, Commonwealth Scientific and Industrial Research Organization) presented the only paper on microwave spectroscopy He has measured the electric field gradients at the oxygen and hydrogen nuclei in HDO and D_2O and has begun a measurement of the magnetic hyperfine splittings

The following papers which were generally concerned with spectrographic apparatus and methods were also presented Dr H Gollnow (Mt Stromlo Observatory, Canberra) described a precision photoelectric setting device (accuracy about 0 5μ) for the measurement of diffuse spectral lines A fast-scanning infra-red (1–5μ) spectrometer equipped with a cooled lead–tellurium detector was described by Dr J Tregallas-Williams (Defence Standards Laboratories, Maribyrnong) Another paper from the same laboratories, by G L White, discussed the application of polynomials fitted by 'least squares' methods, instead of the Friedel–McKinney equation, for the calibration of infra-red spectrometers Some molecular spectra excited by shock waves were shown by Dr C L Cook (Weapons Research Establishment, Salisbury), and the part played by a photographic spectrograph in routine control in the steel industry was outlined by J H Savage (Australian Iron and Steel, Port Kembla) Another paper on emission spectroscopy was given by J M Nobbs (Defence Standards Laboratories, South Australia), who described some of the effects of pulse shape on the spectral characteristics of pulsed discharges He pointed out that the exponential shapes commonly used yielded lower sensitivities than most other shapes

The final morning session of the conference took the form of a small symposium on atomic absorption spectroscopy, with a review and five research papers on the subject A Walsh (Division of Chemical Physics, Commonwealth Scientific and Industrial Research Organization) reviewed the present status of emission and atomic absorption spectroscopy Recent advances in emission spectroscopy include better sources, the use of photomultipliers and the availability of vacuum instruments The use by Margoshes and Scribner of a plasma-jet as a spectroscopic source was a new development which will be followed with great interest However, the need for standards remains This results essentially from three types of interference, namely, chemical, radiative and excitative Atomic absorption spectroscopy avoids two of these but not the chemical interferences In the opinion of the reviewer the value of atomic absorption spectroscopy has been established and it seems that any analysis that can be done by flame emission methods using atomic lines can be done as well and often better by atomic absorption methods

J E Allan (Department of Agriculture, Hamilton, New Zealand) described the analysis of magnesium by atomic absorption The measurement is carried out simultaneously with flame emission analyses for calcium, sodium and potassium, the other major cations present in plants and soils The magnesium determination can be performed with the same ease as, and probably with greater reliability than, calcium, sodium and potassium determinations The minor elements zinc, iron and manganese have also been determined by atomic absorption directly on plant ash solutions or soil extracts, but copper at present requires prior extraction with an organic solvent D J David (Division of Plant Industry, Commonwealth Scientific and Industrial Research Organization) spoke about some of the chemical interferences encountered in applying atomic absorption to the analysis of plant material and soil extracts In plant material analyses, he finds no interference for zinc, iron, copper and magnesium but he finds that calcium absorption is depressed by phosphate, aluminium and silicate This interference is eliminated with 0 6 per cent magnesium ions and 2 per cent, volume/volume, sulphuric acid With soil extracts the atomic absorption analysis is straightforward for sodium, potassium and magnesium, but in this case the interference with calcium is controlled by 0 15 per cent strontium ions These two papers showed that many analyses important in plant and animal nutrition can be carried out successfully by the atomic absorption method

Dr J B Willis (Division of Chemical Physics, Commonwealth Scientific and Industrial Research Organization) discussed the determination of blood serum calcium and magnesium levels by atomic absorption Large quantities of strontium ions or the disodium salt of ethylene diamine tetracetic acid are needed to overcome the interference of phosphate and protein Duplicate measurements for calcium and magnesium can be made directly on about 0 25 ml of serum diluted 10–20 fold Dr P Brownwell (Botany Department, University of Adelaide) is interested in analysing for very small quantities (about 0 01 p p m) of sodium, which is a micronutrient for *Atriplex vesicaria* The flame photometric results are misleading when the calcium concentration exceeds 0 02 *M* The atomic absorption method using '*Si-ro-spec*', a simple instrument designed by Box and Walsh for this purpose, at present enables accurate measurements of about 1 p p m sodium in the presence of large excesses of calcium (4 *M*) and potassium

The final contribution, by Dr B M Gatehouse and Mr A Walsh (Division of Chemical Physics, Commonwealth Scientific and Industrial Research Organization), was concerned with the direct analysis of metals and alloys By sputtering from a metal surface in the presence of about 1 mm mercury pressure of neon they were able to obtain a calibration curve and to determine 1 p p m silver in a copper–silver alloy They suggested that this method may be suitable for elements such as aluminium and boron which do not give atoms in the flame

In a concluding discussion members agreed unanimously that a standing committee should be set up to organize similar conferences at regular intervals.

NORMAN S HAM

PROTEIN BIOGENESIS

A COLLOQUIUM on "Specificity in Protein Biogenesis" was held in Louvain during June 8–9 by the Centre interuniversitaire de Recherches enzymologiques, a government-sponsored association grouping several Belgian biochemical laboratories. The aim of the organizers was to bring together scientists actively engaged in research on protein synthesis and to establish new contacts with the Belgian groups interested in this field. The meeting was arranged on an informal basis and the speakers were asked to discuss freely the current work of their laboratories; the lectures will not be published.

Present ideas on the relationship between deoxyribonucleic acid and protein structures were lucidly summarized and discussed by C. Levinthal (Massachusetts Institute of Technology). Since deoxyribonucleic acid and protein are both linear polymers, it would seem that a simple relation should exist between the arrangement of the amino-acids in the protein and that of the nucleotides in deoxyribonucleic acid of the corresponding gene—probably a point-to-point correspondence between the two sequences. Some of the characteristics of the coding system serving to translate one sequence into the other can be deduced from what is known about deoxyribonucleic acid and protein structure. It seems feasible at present to check experimentally the idea of collinearity between the structure of the two types of polymers. Find an organism in which genetic maps can be established with great accuracy, choose an enzyme molecule of moderate size produced by this organism and devise a good selection principle for recovering the useful mutants. Isolate several mutants of the genetic locus of the enzyme, map the mutation sites, isolate the abnormal proteins, if any, which are produced in place of the normal enzyme by the mutants, and locate the differences within the protein molecules. This gives a test of the correspondence between deoxyribonucleic acid and protein fine structure.

C. Levinthal described the progress of his own work on the genetic control of the formation of a phosphatase in *E. coli*. Thirteen different mutants resulting from mutations within the locus of the phosphatase have been isolated so far; the linear order of the mutation sites has been established by a very interesting use of the transfer of genetic material during bacterial conjugation. Unfortunately only one of the thirteen mutants produced a recognizable modified phosphatase protein. Both the normal and the abnormal enzymes have been isolated, and their structure is now being studied. Future developments along this line of research will be watched with great interest.

In bacterial systems, genetic analysis is ahead of chemical knowledge. In man, on the other hand, where genetic analysis is at a great disadvantage, brilliant success has been achieved on the chemical side. J. Hunt (Cambridge) reviewed the main results obtained by the Cavendish Laboratory group on the structure of abnormal hæmoglobins. This work will undoubtedly become a classic of genetics and biochemistry. Hæmoglobins *S* and *C* differ from the normal protein in only one detail: the replacement of one glutamic acid in the β chain by valine or lysine respectively. Hæmoglobin *E* differs from normal hæmoglobin by the replacement of another glutamic residue by lysine; in hæmoglobin *G*, still another glutamic is replaced by glycine. Thus genetic differences presumably arising from mutations can result in the replacement of individual amino-acids at specified places in the polypeptides.

J. Hunt further described in detail his recent work on fœtal hæmoglobin. He has shown that one of the two polypeptide chains of fœtal hæmoglobin (chain α) is identical with that of normal adult hæmoglobin. This discovery opens new perspectives and will certainly give important information on the mechanism of the genetic control of protein structure, for here is a simple case of differentiation at the molecular level. The structure of fœtal hæmoglobin of infants carrying genes of abnormal adult hæmoglobins will be very informative. It might indicate whether the switch from fœtal to adult hæmoglobin during development results from the inhibition of the activity of a gene and the unveiling of another gene, or whether the change occurs somewhere between the gene and the protein-making system and consists in a change of expression of the same gene.

Other aspects of the control of the synthesis of specific proteins were discussed by B. Magasanik (Harvard University), who considered the phenomena of enzyme induction and repression and the function of ribonucleic acid in the synthesis of bacterial protein. B. Magasanik reported results obtained in his laboratory on various mutants which require amino-acids, nucleic acid precursors, or certain energy sources. By a very ingenious use of these mutants, several aspects of the correlation between ribonucleic acid content and level of protein synthesis were checked. Increased rate of protein synthesis goes together with an increased content of the bacteria in both soluble ribonucleic acid and ribosome ribonucleic acid. This is comparable to the well-known relation found in higher organisms. Studies on ribonucleic acid and protein synthesis during adaptation, especially in 'diauxie' experiments, indicate that the synthesis of new ribonucleic acid does not accompany enzyme adaptation. The results are compatible with a catalytic function of ribonucleic acid in protein synthesis, and with the view that induction and repression of enzyme synthesis rest upon the control of the activity of pre-existing protein-forming centres, rather than on the formation or destruction of such systems.

The existence of specific ribonucleic acid molecules capable of carrying some sort of genetic information is established by the discovery that pure virus ribonucleic acid is able to cause infection. Present knowledge on the structure of tobacco mosaic virus was summarized by H. Fraenkel-Conrat (University of California), who presented results of his current work on the molecular size of the virus ribonucleic acid. End-group determination in the virus acid by a combination of tracer methods with specific enzymic degradation and controlled chemical oxidation indicates that each virus particle might contain one single molecule of ribonucleic acid made up of some 6,000 nucleotides in one chain. The polypeptide chain of the virus protein contains only about 150 amino-acid residues. It would seem, therefore, that the ribonucleic acid of the virus is large enough to carry much more information than that which is required for controlling the primary structure of the protein unit contained in the finished virus This raises several problems for future research H Fraenkel-Conrat also reported very interesting results on a special state of the virus ribonucleic acid at the beginning of infection

Another approach to the specific function of ribonucleic acid in protein synthesis is the artificial modification of the structure of the acid This has been done by chemical means in the case of virus ribonucleic acid In bacteria, composition of the acid can be changed by growing the organisms in the presence of analogues of the normal purines or pyrimidines F Gros (Institut Pasteur, Paris) gave a very clear account of research on the effects of fluorouracil on protein synthesis in *E coli* Incorporation of all the individual amino-acids does not respond in the same way to fluorouracil For example, the incorporation of proline and tyrosine is depressed whereas that of arginine is stimulated These changes appear to reflect qualitative as well as quantitative modifications in the protein equipment of the organism, indicating that the analogue may actually interfere with the agents which control protein structure A phosphatase formed in the presence of the analogue has a normal enzymic activity although it contains less proline than the normal enzyme , thus it is probably slightly modified at a place which is not important for the catalytic properties of the protein On the contrary, β-galactosidase synthesis is abolished and replaced by the formation of some related inactive protein It is striking that fluorouracil specifically reduces the fixation of proline and of tyrosine on soluble ribonucleic acid at the same time as it reduces the incorporation of these same amino-acids into the proteins This indicates that soluble ribonucleic acid plays an important part in the specificity of protein formation These results also support current views according to which activated amino-acids are bound to soluble ribonucleic acid before condensing into polypeptides

T Hultin (Wenner Gren Institute, Stockholm) reported observations on animal tissues which indicate that another pathway of amino-acid incorporation might exist beside that passing through soluble ribonucleic acid That the latter must also be operative was shown by several of his results which agree with the classical scheme However, he obtained, by means of new techniques of isolation of ribosomes and by fractionation of supernatant preparations, a system in which amino-acids are incorporated into proteins in the particles in the absence of soluble ribonucleic acid A protein of the supernatant is required for incorporation with this system Protein synthesis which can occur in isolated mitochondria or nuclei appears to depend on the presence in these cell organelles of particles closely resembling the ribosomes of the cytoplasmic ground substance

Of great benefit to the meeting was the presence in the audience of biochemists from different countries who had taken part a few days before in Brussels in the Solvay Conference on Nucleoproteins All the lectures were followed by very good discussions The meeting was closed by a general discussion which concerned the function of the various ribonucleic acid fractions, the transfer of information from gene to protein, and coding problems

H CHANTRENNE

PROGRESS IN GAS CHROMATOGRAPHY

AN informal symposium of the Gas Chromatography Discussion Group (associated with the Hydrocarbon Research Group of the Institute of Petroleum) was held at the University of Bristol on September 25 under the chairmanship of Mr C S G Phillips

Dr F H Pollard commented on the enthusiasm and free interchange of ideas among workers in this field which was undoubtedly responsible for the present advanced state of the art Having regard to the success achieved by him in the field of inorganic separations by paper chromatography, it was not surprising that he should mention the possible separation of such materials by gas chromatography

The outstanding feature of the meeting was the demonstration by Mr R P W Scott of the presentation of gas chromatographic data with a high-persistence cathode ray tube With capillary columns it is possible to effect separations at speeds much greater than the response of conventional recorders, and in order to take full advantage of the technique in its application to kinetic and other studies a means of high-speed recording is essential Mr Scott, using a 70-ft column, demonstrated separations of 100° C boiling-range samples in less than 1 min with his apparatus which, inclusive of automatic repetitive sample injection system, cost less than £80 for materials

The discussion which followed a paper by Mr C L A Harbourn on quantitative determinations showed that this aspect of the subject is one that affects most users of the technique As yet, however, if one uses the published literature as a guide, it would appear to have received very little attention The well-prepared paper covered methods of peak measurement, sources of error and repeatability of calibration, internal standard, and normalization methods, and interpretation of unresolved peaks Recent developments in integrators and the use of analogue computers and tape recorders were also discussed

Some of the practical aspects of the measurement of retention volumes were dealt with by Dr G W A Rijnders, and Dr C R Patrick mentioned some of the problems attached to 'scaling-up' analytical columns to sizes capable of handling up to 10-gm samples The values of height equivalent of a theoretical plate (H E T P) increase and the much higher volumetric flow-rates necessitate modifications to the design of hot-wire detectors Mr D H Desty read a paper by Dr J Janak, who unfortunately was unable to be present, describing the application of gas chromatography to the identification of structure of involatile substances by pyrolysis and subsequent analysis of the products

Members attending, among whom were some from the United States and Europe, were able to inspect and see working a good selection of the commercial instruments now available for laboratory and process control work

C G SCOTT

ORIGIN AND DISPERSAL OF FLOWERING PLANTS

A TOTAL of no less than thirty-nine papers presented at the Montreal Ninth International Botanical Congress during August 19–29 dealt directly or indirectly with the origin and dispersal of flowering plants, providing a modern commentary on these two long-standing fundamental questions

A review of the evidence for a pre-Cretaceous origin was given in two invited papers before a joint symposium of the palæobotany and morphology and anatomy sections In the first of these A J Eames, discussing morphological testimony for a Palæozoic origin, maintained that studies in the Ranales showed that the primitive flower was bisexual and beetle-pollinated, that unisexuality and diœcism accompanied by insect pollination, then anemophily and the elaboration of simple sporophylls, were major advances which must have required long periods of time These steps had already been taken before the Lower Cretaceous Eames suggested that the search for ancestral angiospermous stock might again be directed towards the late Palæozoic ferns, even possibly the homosporous ones Besides the evidence from comparative anatomy, there was direct evidence in the form of pollen, wood and leaf impressions from the Triassic and Jurassic

L Van der Pijl opening the Darwin Centennial Symposium, considered that the angiosperm flower must have differentiated in contact with beetles, already present in the Permian, whereas insects are not common until the Cretaceous Persisting traces of beetle pollination, he pointed out, are found in extant groups V Grant, in an account of the diversity of pollination systems in the Polemoniaceae, appeared largely to concur with Van der Pijl's view of the primitive flower In different papers, A S Foster described how certain herbaceous ranalean forms might represent an early angiospermous type with dichotomous venation, W N Stewart proposed that Conrad's monophyletic classification of vascular plants be revived, despite the recent trend towards a polyphyletic one

The difficulties inherent in the discovery of palæobotanical evidence of angiospermous origins were illustrated by N H Hughes, who demonstrated Jurassic probably gymnospermous pollen, and by W G Chaloner, who described how carboniferous plants with spores which could be found occurring commonly could nevertheless be poorly represented as macro-fossils On the other hand, in a paper on Palæozoic marine sequences from New York and Australia, W R Evitt further documented the antiquity of vascular plant stocks

In the second invited paper of the first symposium D I Axelrod dealt primarily with a third line of evidence, namely, modern distribution patterns He illustrated with tables the preponderance of families entirely or largely tropical or with a large tropical section Basic distribution patterns which emerged were tropical, tropical and extra-tropical, boreal or austral, dry and temperate derived Such evidence, Axelrod considered, favours the supposed existence of angiosperms in the later Palæozoic in upland tropical regions where they underwent quantum evolution

Many biosystematic, palynological and palæological papers dealt to a greater or lesser extent with flowering plant distribution E Hulten, opening a symposium on alpigenous and arctogenous plants with specific illustrations of various types of circumpolar evolution, pointed out that increasing knowledge of this kind provided further material for Quaternary phytogeography W A Weber directed attention to the southern survival of many arctic and sub-arctic species, more especially in the Colorado Rocky Mountains E Dahl, considering amphi-Atlantic arctic-alpine plants, discussed evidence for their migration across a Pliocene or Pleistocene land-bridge Dahl suggested that the West Arctic Scandinavian species survived the last ice-age in coastal refugia rather than in Central Europe A Tolmatchev, in an abstract, stated that the Arctic flora was first formed in the Pliocene–Pleistocene, from indigenous elements in the treeless areas on mountain summits and slopes and similar open habitats T W Bocher held that most arctic or montane species groups are probably of Tertiary origin, but that considerable speciation occurred within these groups in the Quaternary, supported by geographical or genetical barriers J A Calder, discussing post-Pleistocene distributions in British Columbia, suggested that extensive refugia had existed in Alaska, the Yukon, also in the mountains of west Mackenzie and the Queen Charlotte Isles during the period of maximum glaciation

On modern montane distributions, K O Hedberg described the Afro-alpine flora as a complex derived from Mediterranean, Himalayan, South African and Temperate, besides Tropical African floras, and which had probably existed since the Miocene J K Morton found a higher incidence of polyploidy in the Cameroons mountain flora than in lowland Ghana, I Manton, in a presentation otherwise restricted to ferns, referred to this Cameroons flora as an "island" one, comparable with that of Ceylon in respect of the occurrence of polyploidy C Favarger described how the incidence of polyploidy in Switzerland in certain alpine groups coincided with a floristic subdivision G S Puri considered that during the Pleistocene glaciation the Himalayas were invaded by conifers, so that pure conifers or oak-conifer seral stages may now be found there alongside oak climaxes In an abstract B Pawlowski stated that there could have been many survivors of an endemic Tertiary flora on the east and some on the west of the Carpathians P Gorchakovsky similarly described how, apart from endemics, the Ural flora was composed of relics from pre-Glacial broad-leaved forests and glacial ones, from mountain steppe of Asiatic origin and from Pleistocene high mountain relics of Asiatic and of Siberian origin

Dealing with restricted aspects of modern temperate floras, A J Sharp thought that much of the flora of the newer coastal plains of Tennessee and the glaciated terrain to the north were segregates of a more ancient flora of the Southern Appalachian highlands L Laasimer divided the flora of Estonia into East Baltic, related to eastern Europe and West Baltic to Central Europe, respectively A A Beetle discussed how, in the southern part of central Wyoming, differences in grass distribution were due to differences in the age and origin of the various species In the Cretaceous, the Tethys Sea, by dividing the Old

World climates, established contrasts between the predominantly tropical panicoid and the predominantly temperate festucoid grass types Describing the phytogeography of Chinese species of *Fraxinus*, Shiu-Ying Hu stated that one species of a primitive group extended to Sumatra, two species from west and central China have close affinities with north American species, one from north China and one from Yunnan are close to European species

For tropical floras, A Liogier held that Cuba, although tropical, drew most of its species from subtropical and temperate North America The present Cuban distributions suggest that the bulk of the flora came chiefly from South America through Central America during the Mesozoic and Cainozoic, when Cuba and Jamaica were united with Honduras L B Smith described how the flora of south Brazil had its greatest source in central Brazil, there being continuous linkages with the Amazon, Andes and Argentine, discontinuous ones with the Amazon, North America, the Andes and Africa The mountainous and the low-lying floras of tropical America were considered by F Miranda to have had a greater diffusion in past Tertiary periods These floras were partially dominated later in tropical zones by a more macrothermic flora, and almost eliminated in North America by a more microthermic one

Papers were provided by K A Chowdhury, E Dorf, W L Fry, J Gray, T Jimbo and K Rasky, describing angiosperms in various Tertiary floras of India, Wyoming, Canada, Oregon, Japan and Hungary respectively C A Arnold and J S Lowther and J F Grayson and R L Pierce illustrated the low representation of angiosperms in two American Cretaceous floras L A Kuprianova described how palynological studies suggested that *Liquidambar* already occurred in the Upper Cretaceous, that it is not a typical representative of the Arcto-Tertiary flora, and indicated ancient floral relationships between the Mediterranean, Central America and Eastern Asia In a paper to the Taxonomy Section, J Ewan reminded botanists that zoogeographical data may prove illuminating in the interpretation of existing floristic patterns, citing examples including that of the wood rat which persists together with the relict Sierra Madrean flora on outlying Rocky Mountain summits A S BOUGHEY

THE NATIONAL HEALTH SERVICE IN BRITAIN

THE Acton Society Trust has produced a valuable survey of the National Health Service in Britain prepared by Sir George Schuster* Part of the report is a discussion of the general problems of leadership in a State service, this has been dealt with elsewhere (see *Nature*, October 10, p 1087).

Sir George then returns to the National Health Service itself He starts with two personal observations With keen appreciation of the achievements of the National Health Service in Britain in these first ten years, and the belief that too little was far better than too much interference from the central authority, he believes that the time has come for a general overhaul and tuning-up of the administrative machine, for an interpretation of the lessons to be learned from the practical experience of these first ten years, and for a new effort, in the light of this practical experience, to understand what is required to ensure that the National Hospital Service can meet the true needs, individual and social, of the people of Britain in these times Secondly, writing as one desperately anxious to see the best use made of this fine Service, he emphasizes the immense burden of current routine work now falling upon the senior staff of the Ministry This has left them with far too little time to attend to many of the things he suggests need to be done

This matter of overburdening the senior officials is not confined to the Health Service, and although its seriousness has often been admitted since the War, there is little indication that much has been done to relieve the situation All these, however, are matters that could bear closely on the work of other sections of the public service, where the administration of highly technical matters and the control of technical and professional staffs are involved It is to such major issues that Parliament might well have been expected to give its attention; but apart from Sir Keith Joseph's reference to the need for a research or planning staff in the Ministry, they were unnoticed in the House of Commons debate on the National Health Service on July 15

It is the quality of Sir George Schuster's thought and the character of his approach rather than his particular proposals that are of most general interest While he has always conceived of the hospital service as a great fighting service, in which the heads of hospital boards should be entitled to expect from the Ministry something like the leadership and direction which army commanders would get from their commander-in-chief and his general headquarters, he stresses the paramount importance of keeping the hospital service human Inadequate leadership, inefficient management, muddled organization can destroy all possibility of the workers in the service getting satisfaction from their work in a manner that keeps alive their enthusiasm and fulfils a sense of vocation This, however, is an essential element in providing what the patients themselves require above all—efficient curative treatment—and Sir George is well aware that good organization is only a means to an end and he reminds us that in the widest sense the welfare of the patients means taking into account their comfort, peace of mind and all the psychological and social implications of stays in hospital

Sir George does not devote space to the consideration of these issues He is content to note them among the great needs and opportunities in this service which call for a combination of hard-headed administrative efficiency, highly developed working skills, single-hearted pursuit of scientific knowledge and human kindness There are other fields in which the demands are no less, and even if in them it might be too much to assert that without human kindness the true purpose and value of the work must fail, without it full success or true efficiency are hard to achieve

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* Creative Leadership in a State Service a General Survey (Hospitals and the State Hospital Organization and Administration under the National Health Service, Sixth and Final Research Paper) Pp iii+80 (London Acton Society Trust, 1959) 4s

Sir George believes, however, that a Government department can function as the directing authority of a great operating service like the Hospital Service in Britain, and the vast expenditure involved could not and should not be removed from the direct control of a Minister responsible to Parliament If, however, the Hospital Service is to remain the direct responsibility of a Minister and a Government department, Sir George considers that more attention must be given to the staffing of that department and to the arrangements for liaison between it and the decentralized formations, and that a central intelligence organization must be provided Further, he suggests that on all three points lessons can be learned from the experience of other Government departments which have responsibilities in relation to operating services

On the first point, he does not see how the Ministry can give the understanding leadership which is required unless the highest posts on its staff are held by officers who have had practical experience of hospital administration at operational level, and in support of his argument he quotes the staffing arrangements of the Fighting Service Ministries and of the Colonial Office Sir George pays tribute to the value of the work done by many officers appointed before such experience was available, and he does not advocate immediate wholesale change but rather exchanges of staff on the lines of the Colonial Office arrangements His stress is laid on the quality of the officers available to fill the various posts and the need in the National Hospital Service for new administrative skills, for which there is at present no readily available source of supply This last, as he recognizes, is a need which often occurs elsewhere to-day as a result of modern development, and the Hospital Service must take deliberate action to meet this need as private enterprise has done in the field of industry

It might be observed here that if this need for statesmanship is to be met in the Health Service, in industry, or elsewhere, those who meet that need must be treated as statesmen There is no place for the type of party politics which seeks to misrepresent opponents or those who may be entrusted with the execution of schemes or policies which are not in line with party doctrine It is significant that in supporting the Acton Society Trust's proposal that the Minister in charge of the Health Service should have a seat in the Cabinet, Sir George stresses the danger of frequent change of office, and his own proposals would make the chief permanent official in the Ministry a professional man

This does not mean that Sir George is here advocating that the expert should be permanently at the top , but his suggestion goes far beyond the claim that the expert should be considered for the highest administrative posts It implies that the expert by virtue of his expertise is particularly suited to supply the type of specialized administration needed He must, of course, possess administrative capacity there is nothing in Sir George Schuster's pamphlet to countenance incompetence in management or administration, but much to stimulate more thought about the way in which to meet the need for administrators and the type of training and experience they should receive

On the second point, that of liaison between the Ministry and the hospital authorities, Sir George suggests that there are lessons to be learned from the best traditions of the inspectors of schools under the Ministry of Education , but here again Sir George pleads for constructive thinking and refrains from specific proposals His stress on joint consultation at the centre and once again on the quality of the liaison officers clearly has implications far beyond the Health Service, and his strongest criticism is reserved for the perfunctoriness with which liaison is often treated Positive measures and constructive thought are always required to provide an effective two-way flow of ideas

Sir George Schuster's major proposal is in regard to his third point and, in line with a main recommendation of the Guillebaud report, he recommends the establishment of a central intelligence and statistical department This, however, should be an integral part of the executive, with its own creative role as a detector of problems and a productive source of wisdom Sir George has in mind something on the lines of the Office of Special Enquiries and Reports under the direction of Michael Sadler at the Ministry of Education, equipped with an intelligence staff which would keep under constant review the development of hospital practice, in its social as well as its medical setting, in Britain and other countries, and which would publish a series of reports which might be accepted throughout the world as authoritative With such a staff the Ministry could not only carry out its own investigations, but could also provide valuable stimulants to work by the hospital authorities Particularly in its social aspects, the research here required needs central guidance and co-ordination, and Sir George's own experience as chairman of a regional hospital board has convinced him of the great flow of evidence of clinical, human and social interest which requires recording, co-ordination and interpretation

Beyond this Sir George points to the need for creative thought, such as demands the services of men of wisdom and comprehension, combined with knowledge of medical affairs How to produce such men and women is one of the real challenges which this rapidly changing world makes on professional organizations to-day, and there is much indeed in Sir George Schuster's comments that deserves careful study by professional men and women of professions other than that of medicine So far as the National Health Service in Britain is concerned, Sir George Schuster's investigation suggests that this is very seriously understaffed as regards first-class administrators in comparison with large industrial organizations, and some improvement here may well be the first step required to implement his more specific proposals to remedying the alleged weakness of the voluntary committee system and to promote the intensive expert study of the hospital cost structure, the full use of efficiency techniques by the hospital authorities, including the introduction of work-study methods, and the application of operational research to some of the problems of the hospital service

These last are clearly proposals limited specifically to the Hospital Service and to some of them an interested group of members of Parliament is already giving attention The Minister of Health has stated that the Ministry's present experimental organization and methods unit is to be enlarged and made permanent, and that he has accepted the offer of a group of management consultants to undertake a series of surveys, at their own expense, to demonstrate the economies and improvements in efficiency which could be achieved in the hospital service by work study

PREVENTING JUVENILE DELINQUENCY

SEVERAL years ago the United States Children's Bureau, as part of its programme on juvenile delinquency, published a report about the effectiveness of measures in delinquency prevention The analysis was based on evaluative studies conducted over the previous twenty-five years or so

The review led to the conclusion that programmes for the prevention of juvenile delinquency had not been notably effective This conclusion was tempered by two facts First, few programmes, relatively speaking, had been evaluated, and most of those not adequately Secondly, many of the evaluative studies were out of date since they dealt with programmes and methods that to-day might not be considered the best Moreover, there were hints that good results had been achieved with certain types of delinquent children in certain circumstances This was notably the case in child guidance work and was perhaps also true of the kind of neighbourhood work associated with the name of Clifford Shaw

Some of the newer programmes and methods seemed, however, to give promise of more favourable findings Among those mentioned in the report were various devices for 'reaching out' to youngsters and their parents with services they were unlikely to seek for themselves , for example, group work with delinquent and predelinquent gangs, case work or group work with 'resistant' families These and other newly devised programmes seemed to be succeeding where older ones had failed and to be benefiting both from the experience of their predecessors and from recent advances in knowledge about human behaviour and motivation

In an issue of the *Annals of the American Academy of Political and Social Science*, measures of delinquency prevention and their effectiveness are continued with reports from practitioners and research workers who have been closely associated with these efforts (322, March 1959)

The most striking change, according to Helen L Wilmer, of the U S Department of Health, Education and Welfare, is in the level of sophistication shown in the reports This is shown in the way the work with delinquent youngsters and their parents is carried on, in the psychological and sociological knowledge underlying the work, and in the methods employed in its evaluation Much has been learned in all these areas in recent years These articles show programmes of delinquency prevention both benefiting from that advance and contributing to it

Perhaps the most important contribution of this series of articles lies in the picture it provides of the kinds of young people who are likely to become chronically delinquent and of the kinds of homes and neighbourhoods they live in The picture is not a new one but is drawn in a way that reveals, more vividly than usual, the fears, the discouragement and the wish to be like other people that characterize these young people and their parents The treatment measures described, both those that would improve the environment and those that are directed toward the individuals, take their direction from this knowledge The knowledge itself is rooted both in the social sciences and in psychology and demonstrates their interrelatedness

The articles deal with small programmes and, in part, short-lived efforts Few of them report scientifically established results Nevertheless, in their conception of what needs to be done and in their suggestions for some ways of doing it, they hold the hope that the problem of delinquency can be reduced if communities are willing to put the effort required into the work

THE ORIGINS OF LOVE

PSYCHOLOGISTS, sociologists and anthropologists commonly hold the view that the infant learns to love through the association of the mother's face, body and other physical characteristics with the alleviation of internal biological tensions, particularly hunger and thirst Psycho-analysts have tended to emphasize the importance of attaining and sucking at the breast as the basis for affectional development Recently a number of child psychiatrists have questioned such simple explanations Some argue that affectionate handling in the act of nursing is a variable of importance, whereas a few workers suggest that the composite activities of nursing, contact, clinging and even seeing and hearing work together to elicit the infant's love for his mother

It is difficult, if not impossible, to use human infants as subjects for the studies necessary to break through the present speculative impasse For several years a group at the Primate Laboratory of the University of Wisconsin has been using baby rhesus monkeys in a study that has begun to yield significant insights into the origin of the infant's love for his mother A report has been prepared by Harry F Harlow*

The interest in infant-monkey love grew out of a research programme that involved the separation of monkeys from their mothers a few hours after birth The investigators were impressed by the deep personal attachments that the monkeys formed for the diaper pads, and by the distress that they exhibited when the pads were removed briefly once a day for the purposes of sanitation The behaviour of the infant monkeys was reminiscent of the human infant's attachment to its blankets, pillows or rag dolls These observations suggested a series of experiments to compare the importance of nursing and all associated activities with that of simple bodily contact in engendering the infant monkey's attachment to its mother Two surrogate mother monkeys were prepared One is a bare welded-wire cylindrical form surmounted by a wooden head with a crude face In the other the welded wire is cushioned by a sheathing of terry-cloth Eight new-born monkeys were placed in individual cages, each with equal access to a cloth and a wire mother Four of the infants received their milk from one mother and four from the other, the milk being supplied in each case by a nursing bottle, with its nipple protruding from the mother's 'breast'

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* *Scientific American* 200, 6, June 1959.

The two mothers quickly proved to be physiologically equivalent The monkeys in the two groups drank the same amount of milk and gained weight at the same rate But the two mothers proved to be by no means psychologically equivalent Records showed that both groups of infants spent far more time climbing and clinging on their cloth-covered mothers than they did on their wire mothers As the monkeys grew older, they tended to spend an increasing amount of time clinging to and cuddling her pliant terry-cloth surface Those that secured their nourishment from the wire mother showed no tendency to spend more time on her than feeding required, contradicting the idea that affection is a response that is learned or derived in association with the reduction of hunger or thirst These results indicate the importance of bodily contact and the immediate comfort it supplies in forming the infant's attachment for its mother, the cloth-covered mother surrogate is an eminently satisfactory mother

The time that the infant monkeys spent cuddling on their surrogate mothers was a strong but perhaps not conclusive index of emotional attachment Would they also seek the inanimate mother for comfort and security when they were subjected to emotional stress ? With this question in mind the monkey infants were exposed to the stress of fear by presenting them with strange objects, for example a mechanical teddy bear which moved forward, beating a drum Whether the infants had nursed from the wire or the cloth mother, they overwhelmingly sought succour from the cloth one, this differential in behaviour was enhanced with the passage of time and the acquisition of experience All tests show that the infant monkey's relationship to its surrogate mother is a full one Comparison with the behaviour of infant monkeys raised by their real mothers confirms this view

While bodily contact clearly plays the prime part in developing infantile affection, other types of stimulation presumably supplement its effects A search has been made for these factors Western culture parents appreciate that rocking a baby or walking with him somehow promotes his psychological and physiological well-being The responsiveness of infant monkeys to two cloth mothers, one stationary and one rocking, was now compared All preferred the rocking mother, though the degree of preference varied considerably from day to day and from monkey to monkey Motion does appear to enhance affection, albeit far less significantly than simple contact The act of clinging, in itself, also seems to have a role in promoting psychological and physiological well-being

Still other elements in the relationship remain to be investigated systematically The warmth of the mother's body would appear to play its part in strengthening the infant's ties to the mother Observations have not yet confirmed this hypothesis Heating a cloth mother does not seem to increase the attractiveness of the mother to the infant monkey and infants readily abandon a heating pad for an unheated mother surrogate Visual stimulation may forge an additional link It is also possible that particular sounds and even odours may play some part in the normal development of response or attention

The depth and persistence of attachment to the mother depend not only on the kind of stimuli that the young animal receives but also on when it receives them Experiments with ducks show that imprinting is most effective during a critical period soon after hatching, beyond a certain age it cannot take place at all From preliminary experiments with monkeys it has been found that their affectional responses develop, or fail to develop, according to a similar pattern

NORTH–SOUTH ANISOTROPY AND ANTICIPATORY INCREASE OF INTENSITY ASSOCIATED WITH THE COSMIC-RAY STORM OF FEBRUARY 11, 1958

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AND

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THE time variations of cosmic rays have been measured during the International Geophysical Year with standard instruments at a large number of places on the Earth, and several studies have been made of the energy dependence of the primary variations and the anisotropy which is often associated with primary variations of intensity From an examination of Forbush-type decreases, Fenton, Fenton and Rose[1] have come to the conclusion that the cause of the transient intensity decreases is variable in its energy dependence from a few BeV to more than 30 BeV The variation in response to transient decreases observed with similar equipment at different stations suggests that a primary anisotropy is present at these times Lockwood[2] has examined the detailed structure of several Forbush-type decreases in the intensity of local neutrons during 1955–58 He finds that in most of the decreases there was a magnetic storm at the onset Flare activity during the preceding 30 hr was high and there was some indication of an intensity maximum during the 12-hr period preceding the start of the decrease He comments that such an anticipatory effect might be due to the albedo of the moving magnetic gas cloud, but that further results are

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* Sometime guest of the Massachusetts Institute of Technology

Table 1 CHRONOLOGY OF EVENTS ASSOCIATED WITH THE FORBUSH DECREASE OF FEBRUARY 11, 1958

ΔC and ΔH respectively indicate the change of cosmic-ray intensity (CR) and of the horizontal component of geomagnetic field at Virginia

Date	U T	Solar event	U T	Terrestrial effect	Cosmic ray features
9-2-58	0207	*2+ Flare		Radio fade-out	
	2053–2120	Type III and Type I radio bursts			
	2139	*2+ Flare *E*04 *S*20		Radio fade-out	
10-2-58	1325	*2+ Flare with major burst radio noise *W*67, *S*12		Radio fade-out	
			2100	CR maximum $+\Delta C \approx +1$ per cent	(1) Anticipatory increase at equator only related to high energy
11-2-58			0120	S C storm	
			0126	$-\Delta H$, $-\Delta C$	(2) Decrease starts at high latitudes
			0130	Aurora	
			0154	$+\Delta H$, $-\Delta C$	
			0300	CR minimum	(3) 0300 minimum at equator
					(4) 0500 minimum in mesons
			0622	X-ray $\Delta H = 0$	
			0635	Maximum absorption, galactic noise of 18 Mc /s	
					(5) 0700 minimum at high latitudes
			0730	X-ray ends	
			0850	X-ray and ΔH	(6) Increase commences
			1000	Maxima aurora	Seen in instruments with high and low energy response Not observed in stations in 120° E belt, nor in the southern hemisphere
			1100	CR maximum	

needed to substantiate any anticipatory effect McCracken and Parsons[3] have made a very interesting analysis of a Forbush-type event which occurred on October 21, 1957 They found that there was a preliminary depression prior to the commencement of the Forbush decrease and they comment that it was not due to the arrival of solar matter at the Earth since it occurred before the magnetic disturbances They conclude from studies made at several stations that the preliminary depression must be attributed to a cause located at some distance from the Earth, and since it is not observed simultaneously at all stations its explanation requires some rather special form of short-lived primary anisotropy McCracken[4] has analysed the anisotropy of a number of Forbush-type decreases which were preceded by decreases Yoshida and Wada[5] have directed attention to increases of intensity which occur after the onset of cosmic-ray storms They believe that the increases are mainly isotropic and have an energy-dependence nearly the same as that of the decreases.

Table 2 PARTICULARS OF COSMIC-RAY NEUTRON MONITOR STATIONS USED IN ANALYSIS

Code	Station	Geog Lat	Geomag Lat	Long	Investigator
A	Murchison Bay	80° N	76° N	18° E	Dr A E Sandstrom, Sweden
B	Churchill	59° N	69° N	94° W	Dr D C Rose, Canada
C	Leeds	53° N	57° N	0°	Dr J G Wilson, England
D	Sulphur Mt	51° N	58° N	115° W	Dr D C Rose, Canada
E	Weissenau	48° N	49° N	9° E	Dr A Ehmert, Germany
F	Ottawa	45° N	57° N	76° W	Dr D C Rose, Canada
G	Mt Norikura	36° N	26° N	137° E	Dr Y Miyazaki, Japan
H	Kodaikanal	10° N	1° N	77° E	Dr V Sarabhai, India
I	Makerere College	0°	2° S	32° E	Dr D M Thomson, Uganda
J	Lae	6° S	16° S	147° E	Dr A G Fenton, Hobart
K	Huancayo	12° S	1° S	75° W	Dr J A Simpson, Chicago
L	Hermanus	34° S	33° S	19° E	Dr A M Vanwijk, Hermanus
M	Mt Wellington	41° S	45° S	147° E	Dr A G Fenton, Hobart
N	Invercargill	46° S	52° S	168° E	Dr N V Ryder, New Zealand
O	Mawson	67° S	73° S	62° E	Dr A G Fenton, Hobart
1	*H*, *I*, *K*	Equator	0–2°		
2	*B*, *C*, *D* *E*, *N*, *O*	High latitude	49–73°		
3	*D*, *F*, *K*	West longitude		75–115°	
4	*C*, *E*, *I*	0-Longitude		0– 32°	
5	*J*, *M*, *N*	East longitude		147–163°	
6	*A*, *E*, *G*	Northern hemisphere	26–76° N		
7	*L*, *M*, *O*	Southern hemisphere	33–73° S		

In connexion with the Forbush-type decrease in cosmic-ray intensity which occurred on February 11, 1958, we have fortunately a large number of other solar and terrestrial observations which give us a unique set of data for following the event from the time it occurred on the Sun These have been summarized by Trotter and Roberts[6] During its second passage on February 9, 1958, a region 58-*B* at 15° S heliographic latitude, then at the central meridian, suddenly underwent very rapid changes in plage brightness and sunspot growth The region flared rapidly throughout the day, half a dozen of the flares were Class 1+ or greater Five of these caused complete short-wave radio fade-outs of considerable duration In addition, these events were associated with unusual solar radio noise burst activity on 2,800, 470 and 167 Mc /s The flux density on 167 Mc /s was very high during February 7–9 An extremely large number of high-speed dark surges were observed on the solar disk, most of them in association with small flares The mean integrated coronal (5303 A) intensity was low during the period Region 58-*B*, which had very intense activity during the second passage in February, persisted with pronounced activity during the third and fourth passages in March and April respectively

The strongest geomagnetic storm with sudden commencement (s c) of the present solar cycle began early on February 11, and almost simultaneously a very spectacular aurora that persisted throughout the night lit up the northern sky as far south as the 35th parallel It was visible on the following night as well. In Table 1, the important events observed on the Sun and on the Earth are summarized in chronological order

We have examined the effect in cosmic rays from data of the high counting-rate meson detector at the Massachusetts Institute of Technology and from a grid of neutron monitor stations distributed (1) in two belts corresponding to the equator and the middle geomagnetic latitudes, (2) in three meridional sections corresponding to 75–115° W, 0–32° E and 147–168° E , and (3) in the northern and southern hemispheres In Table 2 are indicated the stations which are included in the grid, particulars of their location and the name of the principal investigator at each station through whose kindness the data have been made available to us Assuming that the variations can be dependent on the primary energy response, on local time or longitude and on the hemisphere, we have grouped stations so as to study one variable at a time with, so far as possible, an equal contribution in each group due to the other two variables The stations from which data have been combined for the various analyses are indicated in Table 2

Fig 1 shows the percentage deviations in the bi-hourly counting-rates of the neutron monitors during successive bi-hourly periods in U T from February 9–12, the deviations in each case being taken with respect to the mean intensity on February 10, which represents a period of 24 hr immediately preceding the onset of the Forbush decrease early on February 11 It is clear from Fig 1*A* that the variation is strongly dependent on primary energy It will be noticed that the meson detector at the middle latitude exhibits a variation which is intermediate between the variation of the neutron monitor intensity at the equator and at the middle latitude stations The middle latitude stations have a much larger percentage decrease than the stations at the equator A minimum intensity is reached at 0300 U T , at 0500 U T and at 0700 U T at the equator, with the meson detector and at the middle latitude stations respectively Moreover, about 12 hr. after the initial decrease, at the equator the intensity returns almost to normal before it decreases again , on the other hand, the recovery occurs only partially at middle latitude stations

A most interesting aspect of the present event is the increase of intensity at 2100 U T on February 10, observed at equatorial stations only, about 4 or 5 hr before the arrival of the solar plasma at 0120 U T , indicated by the storm with sudden commencement and a number of other terrestrial effects The second increase, or the recovery of intensity at 1100 U T on February 11, is seen to be much more significant at the equatorial stations and in the meson detector at Cambridge than at the middle latitude stations It would thus appear that both events, which appear to be increases, are particularly characteristic of the high-energy component of the primary radiation In contrast, the first minimum of the Forbush event is larger and occurs later for low-energy than for high-energy primaries

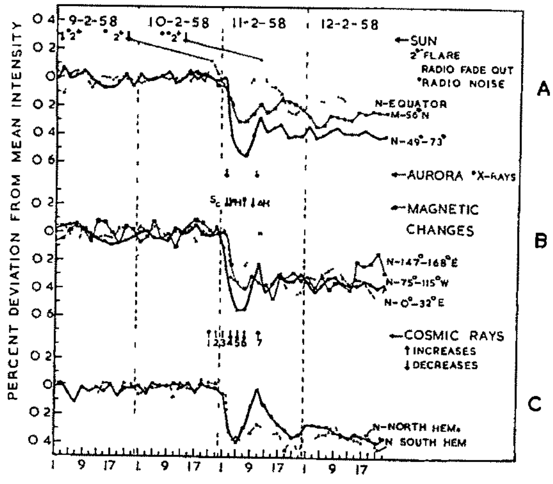

Fig 1 Cosmic-ray intensity changes and associated solar and terrestrial effects for the cosmic-ray storm of February 11, 1958 Relationships of changes are indicated separately in *A* for low and medium latitudes and primary energy response, in *B* for meridional sections and in *C* for hemispheres

In Fig 1*B* the variations of intensity at stations in the three meridional belts are compared It is seen that there are significant differences in the initial decrease, indicating the existence of an anisotropy The most remarkable feature is the complete absence of the second increase at 1100 U T on February 11 at stations in the east meridional section (147° E to 168° E longitude), as also at stations in the southern hemisphere for which a comparison with the northern hemisphere is shown in Fig 1*C* The second increase of intensity is thus characterized by a strong anisotropy not only parallel to the ecliptic, but also perpendicular to it This is perhaps the first evidence for an anisotropy of the latter type In contradiction to the view of Yoshida and Wada, we believe that the second increase is mainly anisotropic and has an energy dependence different from the mainly isotropic Forbush decrease

The main event observed early on February 11 in cosmic rays, in geomagnetism, in the aurora and in X-rays at high altitudes is undoubtedly related to the major solar outburst from region 58-*B* between 2053 and 2139 U T on February 9 We would like to suggest here that solar plasma reached the interaction distance of the geomagnetic field at about 0120 U T on February 11, but that for several hours prior to that, there was a cosmic-ray effect which involved an increase of the radiation During the second increase of cosmic-ray intensity on February 11, we have an increase of cosmic-ray intensity occurring with a strong aurora and change of the horizontal component *H* of the geomagnetic field This contrasts with the association of the aurora and the change in magnetic field with the large decrease of cosmic-ray intensity about 10 hr earlier From other geophysical evidence it is believed that the main plasma outburst streamed past the Earth in 10–12 hr and it appears that the second increase of cosmic-ray intensity is related to the departure of the plasma cloud There was a 2^{+} flare with major burst of radio noise at 67° W heliographic longitude, which occurred at 1325 U T on February 10 It is worth while examining whether the second increase is related to the arrival of fresh solar particles from this flare If, in order to explain the terrestrial influence of a solar event far removed from the central meridian to the west, one postulates the presence of a guiding path of solar magnetic lines of force stretched out to the Earth by earlier streams or an outward solar wind, it would be difficult to explain the 24-hr delay for solar particles of even a few MeV energy We are thus inclined not to associate the second event with the solar outburst on February 10

We believe that in the two increases and the main decrease observed with the cosmic-ray storm of February 11, 1958, we have essentially three types of modulation process One is directly associated with the moving plasma, probably related to the magnetic fields in the shock front and gives increases as well as decreases of intensity along with anisotropy The second gives decreases of intensity and is related to a process which has a sharp onset but a relatively long time constant of recovery The first is often more effective for high primary energies than low, but the second is much more effective for low than for high energies

The large anisotropy parallel to the north–south and east–west directions in the second increase poses an important problem The different motions of solar particles trapped by the geomagnetic field have been discussed by Gold[7], and before average conditions are established round the globe there is probably a basis for major differences in conditions over the hemisphere and at different meridional sections immediately following the arrival of a new cloud of solar particles But the time involved is very short compared to the observed effect which shows up over periods of several hours Moreover, even though changes in the Van Allen radiation belts could perhaps provide an adequate mechanism for the perturbation of the geomagnetic field, and through it alter cosmic-ray intensity, a quantitative evaluation of the effect has not so far been undertaken

We are grateful to Mr S R Thakore and to the computation section at the Physical Research Laboratory and to Miss Britt at the Massachusetts Institute of Technology for help in analysing data One of us (V S) wishes to express gratitude for the hospitality of the Laboratory for Nuclear Science, Massachusetts Institute of Technology, and for financial assistance from the Department of Atomic Energy of India The work at the Massachusetts Institute of Technology has been assisted by the joint programme of the Office of Naval Research and the U S Atomic Energy Commission, and one of us (R P) is supported by a fellowship of the Conselho Nacional de Pesquisas, Brazil, which are gratefully acknowledged We have had many stimulating discussions with B Rossi and T Gold

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MEASUREMENT OF THE EFFECTS OF PISTON MASS AND BURSTING PRESSURE ON THE MOTION OF A PISTON IN A HYPERSONIC GUN TUNNEL

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A HYPERSONIC gun tunnel[1] is essentially a blow-down tunnel with a shock compression heater to generate a high-temperature reservoir of gas This heater consists of a high-pressure vessel separated from a long barrel by a diaphragm and light piston (see Fig 1) When the pressure is high enough the diaphragm bursts and drives the piston down the barrel A shock wave forms ahead of the piston and is reflected from the almost closed nozzle end of the barrel, causing several compressions of the gas within the barrel and raising the temperature The piston finally comes to rest with the pressures on both

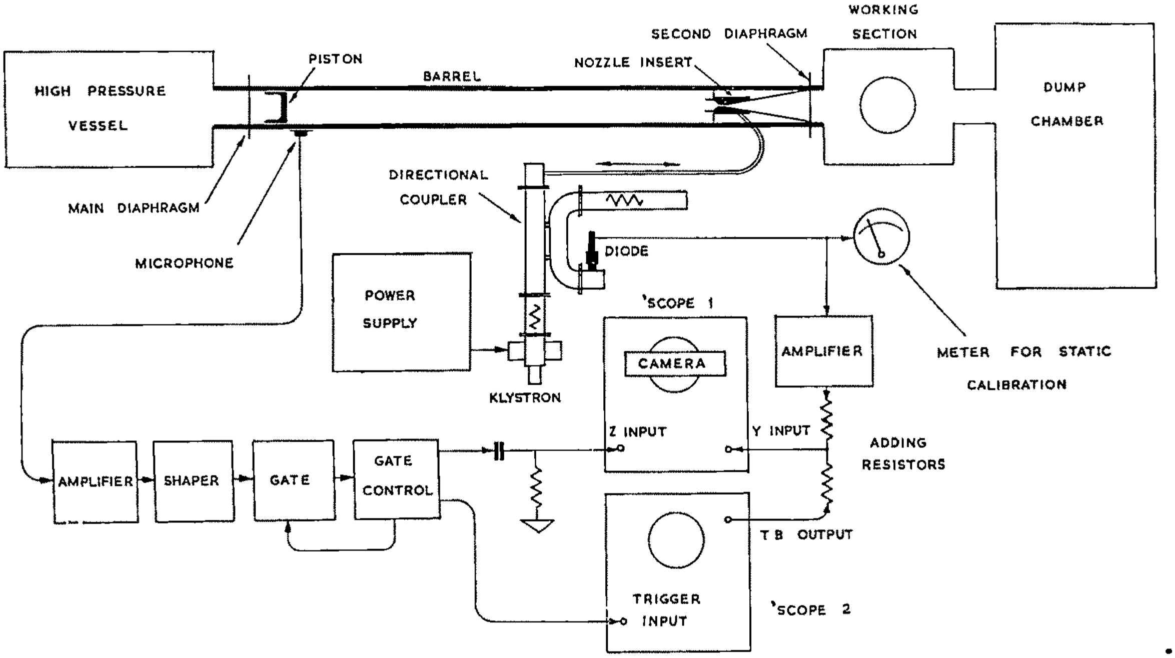

Fig 1 Layout

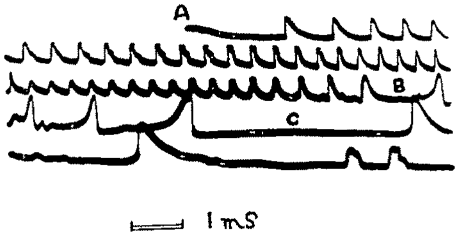

Fig 2 Typical oscilloscope record

sides equal Both the mass of the piston and the bursting pressure will affect the performance of the tunnel

One of the investigations into the operation of the gun tunnel at the Imperial College of Science and Technology, London, was to find how the bursting pressure and piston mass affect the motion of the piston down the barrel This was done by a microwave technique[3], the barrel being turned into a long resonant cavity by coating the face of the piston with a conducting material, either a silver colloid paint or by gluing and screwing on a dural disk Microwaves are injected at the nozzle end and resonance occurs with the piston at every half wave-length By detecting and recording these resonances an analysis of the piston motion is possible

The generator is a 200-mW , 10-cm klystron feeding a wave-guide directional coupler To reduce the tendency for the klystron frequency to follow the changing resonant frequency of the barrel cavity, an attenuator is inserted between the klystron and the directional coupler The purpose of the directional coupler is to sort out signals according to their direction, so that only the reflected waves coming from the barrel reach the diode Power is fed from the klystron to the probes mounted in the nozzle insert through a co-axial cable These probes are arranged not to interfere with the normal working of the tunnel while still exciting a radially symmetric mode (TM_{01}) in the barrel During a run the probes are protected by a nylon block The probes are matched to the barrel cavity so that under conditions of resonance there is little power reflected back along the co-axial feeder However, when the piston moves from the resonant position the subsequent mismatch causes power to be reflected and is detected by the diode on the directional coupler Hence a resonant point is indicated by a drop in the voltage output from the diode The drop in voltage is recorded by an oscilloscope and camera About fifty resonant points have to be measured and, as one sweep of the cathode ray tube has insufficient resolution, a raster type of display was used with a second oscilloscope providing the vertical time-base Oscilloscope 1 was arranged to sweep continuously but with the beam blanked off, and oscilloscope 2 brightened up the first beam when triggered from a bursting signal picked up by a microphone The time-base from the second oscilloscope was then added to the diode output to displace consecutive lines on the recording tube, producing a raster display. One trouble encountered was that the time-base voltage biased off the diode and reduced the signal to nothing This was cured, with the attendant advantages of a larger signal, by inserting a small self-contained transistor isolating amplifier between the diode and the adding resistors (see Fig 1) The amplifier has a voltage gain of 17, a frequency response of 15 c /s to 500 kc /s ± 3 db with a high input and low output impedance Two *OC* 45 transistors are used A similar amplifier was also used as a microphone amplifier Because of the resulting 'ring' and general noise of a burst, several traces were superimposed for each run as the second oscilloscope triggered more than once To ensure that only one trace was obtained a trigger and gate system was adopted This amplifies and shapes incoming signals from the microphone and passes them to a gate A pulse coming from this gate closes the gate

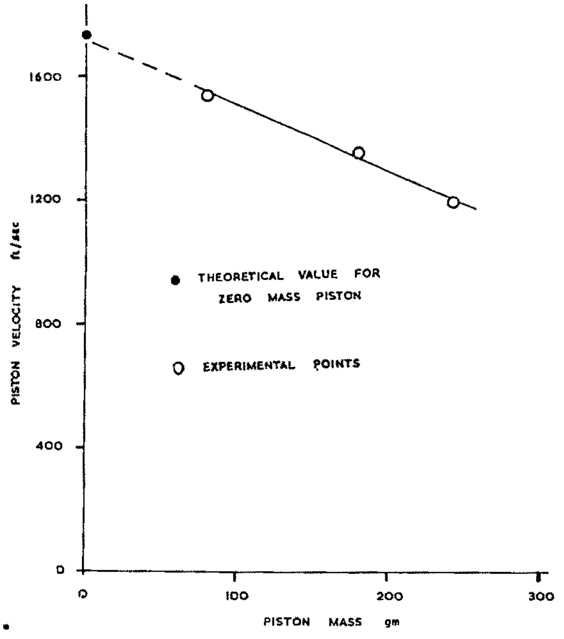

Fig 3 Variation of piston velocity with mass

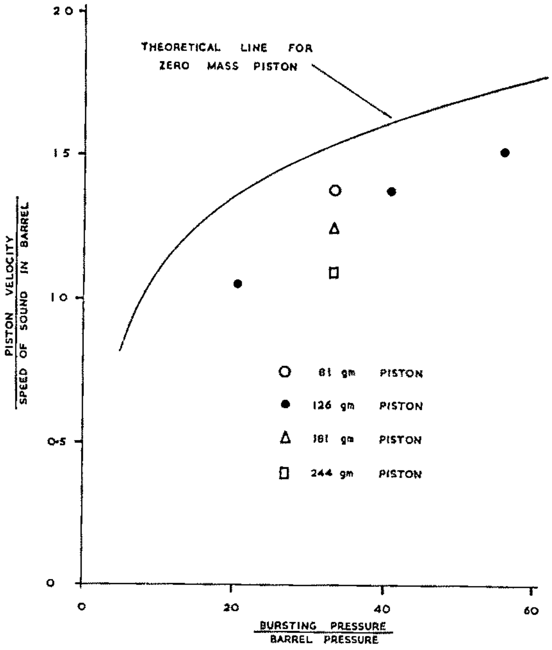

Fig 4 Variation of piston velocity with bursting pressure

and triggers the second oscilloscope Hence only one trace is possible before the system is reset by opening the gate manually

A typical record is shown in Fig 2 Starting at A, which is arranged to be on a resonant point for reference, the distance between pips becomes less, indicating acceleration of the piston, until the third line down where after a rapid deceleration the waveshape is seen to reverse, at B, indicating that the piston has reversed and is now going the other way down the tube On the fourth line at C another reversal is evident The resonant points are indicated by positive pips because the amplifier reverses the sign of the signal

These film records were analysed to give a plot of piston position (x) against time (t) From such plots the maximum piston velocity is taken. Figs 3 and 4 summarize these results Initial acceleration was also measured from the x–t plots assuming the acceleration to be constant over the first few stations, the results being

Bursting pressure (lb /sq in)	Acceleration
300	4,000g
485	5,400g
600	7,200g
825	15,000g

I am indebted to Mr J L. Stollery for his direction and help in the foregoing work, and to Mr P D. Church for his analysis of the traces

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A STRUCTURAL MODEL FOR MONATOMIC LIQUIDS INCLUDING METALLIC LIQUIDS

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ALTHOUGH the melting point (T_m) is generally determined thermodynamically, it is interesting that Lindemann's geometrical law[1] is effective in determining the melting condition of solids So we have studied the structure of liquids at their melting points in the hope of finding some similar law

So far, radial distribution curves for 18 monatomic liquids near their melting points have been obtained by X-ray or neutron diffraction measurements, and they give co-ordination numbers (Z) and the distance (r_1) of the nearest neighbour However, the values of Z so far obtained are less reliable than those of r_1, it is probable that in some cases we obtained low values Therefore, we calculated Z from r_1 and the bulk density (measured) assuming a quasi face-centred cubic lattice The calculated values Z_{cal} were between 10 and 11 5 (mean value 10 85, about 90 per cent of 12 Table 1)

Table 1 DATA FOR RADIAL DISTRIBUTION CURVES NEAR T_m

	r_1 (A)	$Z_{ob.}$	$Z_{cal.}$	A_{ob} (A)	A_{cal} (A)*	r (3)
He (*a*)	3 85	10 5	10 5	2 85	3 36	—
Ar (*b*)	3 86	8 0	10 5	3 40	3 37	—
Xe (*c*)	4 43	9 4	10 4	3 84	3 87	—
Li (*d*)	3 24	9 8	*12 7*	*2 60*	2 83	2 74
Na (*e*)	3 83	9 5	11 2	3 21	3 34	3 43
K (*f*)	4 64	8 0	10 8	3 95	4 05	*4 36*
Au (*g*)	2 86	11 0	10 4	2 42	2 49	2 52
Zn (*d*)	2 94	10 8	*13 7*	*2 33*	2 57	*2 40*
Cd (*d*)	3 06	8 3	10 4	2 60	2 67	2 72
Hg (*h*)	3 10	8 3	10 3	2 68	2 70	2 78
Al (*d*)	2 96	10 6	11 6	2 50	2 58	2 50
Ga (*g*)	2 77	11 0	9 5	2 43	2 42	2 45
In (*d*)	3 30	8 5	11 3	2 86	2 88	2 96
Tl (*g*)	3 30	8 0	10 1	2 85	2 88	3 06
Ge (*g*)	2 70	8 0	—	2 26	2 36	2 37
Sn (*i*)	3 23	9 1	10 7	2 79	2 82	2 77
Pb (*j*)	3 40	9 4	10 3	2 93	2 96	3 02
Bi (*j*)	3 40	8 0	9 6	2 90	2 97	3 04

(*a*) Gordon, Shaw and Daunt, *J Phys Chem Solids*, 5, 117 (1958) (*b*) Eisenstein and Gingrich, *Phys Rev* , 62, 261 (1942) (*c*) Campbell and Hildebrand, *J Chem Phys* , 11, 334 (1943) (*d*) Gamertsfelder, *J Chem Phys* , 9, 450 (1941) (*e*) Trimble and Gingrich, *Phys Rev* , 53, 278 (1938) (*f*) Thomas and Gingrich, *J Chem Phys* , 6, 411 (1938) and Gingrich and Wall, *Phys Rev* , 56, 336 (1939) (*g*) Hendus, *Z Natforsch* , 2a, 505 (1947) (*h*) Vineyard, *J Chem Phys* , 22, 1665 (1954) (*i*) Takeuchi and Furukawa, Meeting of Japan Inst Metals (April, 1958) (*j*) Sharrah and Smith, *J Chem Phys* , 21, 228 (1953) *$A_{cal} = r_1/(1\ 5)^{1/3}$

The shape of the curves was analysed by Wall's theory[2] using the spherical free volume of radius σ According to this theory, $(r_1 - \sigma) = A$ corresponds to the position on the shorter side-branch at a height of 34 4 per cent of the maximum value in the first peak of the curve $4\pi r\rho(r)$, where $\rho(r)$ is the atomic number density at a distance r from any atom Hence we measured A_{ob} from radial distribution curves, and obtained the empirical formula $r_1/A_{ob} = (1\ 5)^{1/3}$ (Table 1)

Assuming a molecule to be a sphere (nearly rigid)[2] of diameter A at T_m, the following model can be postulated Let V_0 be the volume at closest packing of spherical molecules of diameter A, then the volume of liquid at T_m is 1 5 V_0 for quasi face-centred cubic lattice But about 10 per cent of the sites in this quasi-lattice are empty, and these spaces are distributed through all interstices, explaining the second peak at 1 9r_1 of the distribution curves Thus the total volume is about 1 65 V_0

Using this model of a reduced form independent of materials, several properties of liquids can be explained as follows Self-diffusion and viscous flow in liquids are easily explained The self-diffusion coefficient of a liquid at its melting point may be expressed[3,4] as $D_m = \gamma\, r_1^2\, \nu_m \exp(\Delta S_D/R) \exp(-H_D/RT_m)$, where $\gamma\, r_1^2$ is the mean square of jump distances, ν_m the frequency of the liquid at T_m and ΔS_D and H_D the activation entropy and energy of diffusion respectively Now γ, ΔS_D, H_D/RT_m and $D_m/(r_1^2\ \nu_m)$ must all be constants independent of the material If ν_m is calculable from Lindemann's formula, $\nu_m = 2\ 8 \times 10^{12}\, T_m^{1/2}\, M^{-1/2}\, V_m^{-1/3}$, where M is the molecular weight and V_m the molar volume, $D_m/(r^2_1\, \nu_m)$ is obtainable from experimental values of D_m, and is nearly constant (Table 2)

The experimental values of H_D/T_m and $H\eta/T_m$ are also nearly independent of the material, where $H\eta$ is an activation energy of viscosity (Table 2) Differences between the liquid metals and other material may be explained by the expansion co-

Table 2 SELF-DIFFUSION AND VISCOSITY DATA (C G S)

	$(D_m/r_1{}^2\nu_m)\times 10^2$	H_D/RT_m	$H\eta/RT_m$	$\eta_{m,ob}\times 10^2$	$\eta_{mcal.}\times 10_2$
Na	0 72 (*a*)	3 28 (*a*)	2 2 (*d*)	0 71 (*d*)	0 59
Hg	0 83 (*a*)	2 15 (*a*)	1 41 (*d*)	2 1 (*d*)	2 07
In	0 73 (*a*)	2 83 (*a*)	1 86 (*e*)	1 94 (*e*)	1 97
Ga	0 79 (*a*)	1 85 (*a*)	1 61 (*d*)	2 14 (*d*)	1 63
Sn	1 32 (*b*)	3 96 (*b*)	1 78 (*e*)	1 95 (*e*)	2 19
Ag	0 74 (*c*)	3 30 (*c*)	1 91 (*f*)	3 88 (*f*)	4 06
Ar	0 98 (*a*)		3 12 (*g*)	0 28 (*g*)	0 11
N_2			3 69 (*g*)	0 31 (*g*)	0 23
CO			3 50 (*g*)	0 32 (*g*)	0 23
CH_4			4 14 (*h*)	0 23 (*h*)	0 20
C_6H_6	0 41 (*k*)	4 99 (*k*)	4 31 (*i*)	0 83 (*i*)	0 90
O_2			3 70 (*g*)	0 81 (*g*)	0 27
CCl_4	1 87 (*a*)	6 60 (*a*)	4 74 (*j*)	2 0 (*j*)	0 55

(*a*) See ref 12 concerning the experimental values of D_m (*b*) Careri and Paoletti, *Nuovo Cim* , II, No 3, 574 (1955) (*c*) Yang, Kado and Derge, *Trans Met Soc A I M E* , **212**, 628 (1958) (*d*) "Liquid Metal Handbook" (1952) (*e*) Culpin, *Proc Phys Soc* , B, **70**, 1069 (1957) (*f*) Gebhardt and Wörwag, *Z Metk* , **42**, 358 (1951) (*g*) Rudenko and Schubnikow, *Phys Z Sowjet* , **6**, 470 (1934) (*h*) *ibid* , **8**, 179 (1935) (*i*) Grunberg and Nissan, *Trans Farad Soc* , **45**, 125 (1949) (*j*) Thorpe and Rodgen, *Phil Trans Roy Soc* , A, **185**, 397 (1894) (*k*) See ref 6

efficients the ratio of which is of the order of 10^{-2} In fact under the condition of constant volume H_D/RT_m becomes 2 14 for CCl_4[5], and 1 26 for C_6H_6[6], from isobaric experiments, and becomes 2 07 for Hg[4], 1 63 for Ga[4], 1 65 for CCl_4[5] and 1 40 for C_6H_6[6] by computation from isothermal experiments using[6] their expansion coefficients and compressibilities

So putting $H_D/RT_m \equiv 1\ 6$ at constant volume, we obtain $\Delta S_D/R = -\ 3\ 1 \pm 0\ 3$ independent of the materials from their values $D_m/(r_1{}^2\ \nu_m)$ of Table 2 $\Delta S_D < 0$ can easily be explained by a more regulated activated-complex configuration composed of planar 4 or 5 atoms in the closest contact than the ordinary irregular configurations Considering the above, it is of interest that *A* nearly coincides with the metallic bond-lengths of co-ordination number 3 calculated by Pauling's theory[7] (*r* (3) in Table 1)

Combining these facts with the Sutherland–Einstein formula[8], $D\eta = kT/(2\pi A)$, we can easily deduce Andrade's formula[9] $\eta_m = 5\ 7 \times 10^{-4}\ M^{1/2}\ T_m{}^{1/2}\ V_m{}^{-2/3}$ putting $D_m/(r^2{}_1\ \nu_m) = 0\ 0067$ The calculated viscosity coefficients at T_m, $\eta_{m,cal}$, are in good agreement with the experimental values $\eta_{m,ob}$ (Table 2)

Table 3. ENTROPY OF LIQUIDS AT T_m (CAL /DEG /MOLE)

	Calculated	Observed		Calculated	Observed
Ar	12 458	12 594 (*a*)	K	18 154	17 816 (*c*)
Xe	18 704	19 04 (*b*)	Au	23 613	23 32 (*d*)
Li	11 170	11 001 (*c*)	Al	16 820	17 00 (*d*)
Na	15 130	15 507 (*c*)	Pb	22 412	22 28 (*d*)

(*a*) Clusius and Frank, *Z Elektrochem* , **49**, 308 (1943) (*b*) Clusius and Roccobini, *Z phys Chem* , **38B**, 81 (1937) (*c*) Evans *et al* , *J Res Nat Bur Stand* , **55**, 83 (1955) (*d*) See Borelius, "Solid State Phys ", **6**, 55 (1958)

Moreover, using Wall–Harasima's free volume theory[2,10], and adding the entropy of random arrangement of vacancies as a cruder treatment of this model, the entropies of the liquids at their melting points were calculated , the values agreed with the observed ones (Table 3)

The above discussion shows that the metallic liquid is not a special liquid Thus we need not consider the ionic unit[4,11,12] in the transport phenomena

The model will become more complete when combined with the recent work of Bernal[13], who explained the essential difference between regular and irregular close-packing arrangements having a volume difference of about 10 per cent, which agrees with our model

A detailed description including further applications will be published elsewhere

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POLYNUCLEAR COMPLEXES OF MOLYBDENUM(II)

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ALTHOUGH molybdenum(II) chloride and its co-ordination complexes have been known for a century, they have received but little attention As a result of the virtual absence of physical studies on these compounds, not only was nothing known of their constitution until a few years ago, but incorrect molecular formulæ were even adopted The relatively recent X-ray diffraction studies by Brosset[1–3] have done much to improve the position, though the bonding present in molybdenum(II) chloride derivatives has never been seriously discussed and many simple physical measurements remain to be done and correlated with the proposed structures A re-investigation of these compounds is now particularly important as they appear to possess a stereochemistry quite different from that indicated for d^4 metal complexes by ligand field theory Therefore molybdenum(II) chloride and its derivatives are being re-examined and it is now possible to summarize some new experimental results and propose a bonding scheme for these compounds This bonding scheme is able to explain why only certain types of ligands form molybdenum(II) chloride complexes

The crystalline compounds studied by Brosset were formulated on the basis of his structure determinations as $[(Mo_6Cl_8)\{(OH)_4(H_2O)_2\}]\ 12H_2O$[1] and $[(Mo_6Cl_8)\{Cl_4(H_2O)_2\}]\ 6H_2O$[2] The structure of the $(Mo_6Cl_8)^{4+}$ group, fully named octa-μ_3-chlorohexamolybdenum(II) and henceforth referred to as the chloromolybdenum(II) group, is given in Fig 1 It is convenient for most purposes to regard the group

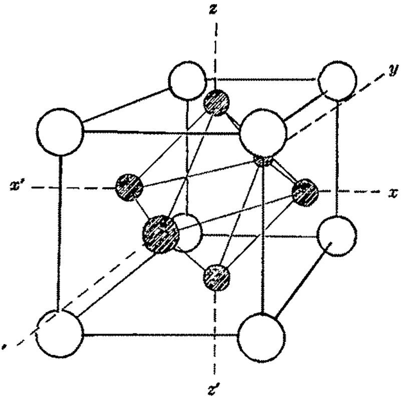

Fig 1 The chloromolybdenum(II) group White circles, Cl, shaded circles, Mo

as a regular face-centred cube and it is presented in this manner in the figure Though the octahedron described by the molybdenum atoms is almost regular, the cube described by the chlorine atoms is somewhat distorted and it is possible that the deviation from strict equivalence of these chlorine atoms may be of some chemical significance Brosset has emphasized that six groups, given in braces in the formulæ above, appear closely associated with the chloromolybdenum(II) unit Fig 1 shows that each molybdenum atom is surrounded by a square planar configuration of chlorine atoms, and can accept one ligand normal to the cube face to achieve co-ordinative saturation The effective co-ordination number of each molybdenum atom, taking into account the four molybdenum close neighbours, would be nine, and it is therefore improbable that more than one ligand could donate to each molybdenum atom Thus six ligands may be accepted by the chloromolybdenum(II) group along the axes *xx'*, *yy'* and *zz'* Whereas the identity of the central ($\mathrm{Mo}_6\mathrm{Cl}_8$) unit is seldom affected, the six ligands are freely variable There is possible a novel range of octahedral complexes, their general character being of the type familiar to the inorganic chemist, but possessing a polyatomic nucleus

The chloromolybdenum(II) group is stable over a wide range of conditions In the form $(\mathrm{Mo}_6\mathrm{Cl}_8)\mathrm{Cl}_4$, that is, MoCl_2, it is not affected by boiling aqua regia or concentrated sulphuric acid heated to fuming, other than the displacement of the chlorine ligands It is stable to more than 800° C *in vacuo*, with probable disproportionation to metal and higher halides above this temperature It is not oxidized by air below 300° C, but above this temperature a dark product is formed However, it is much more sensitive to aqueous alkali giving molybdenum(V) hydroxide and hydrogen At room temperature and *p*H 12, a chloromolybdenum(II) solution shows some signs of decomposition in about 10 hr, though at higher *p*H and temperature decomposition can be complete in a few minutes It is noteworthy that the reagents most disruptive for the ($\mathrm{Mo}_6\mathrm{Cl}_8$) group are the strong electronegative complexing agents, namely, OH^-, F^- and NCS^-, though attack by these is rapid only at high temperatures It is therefore possible that the decomposition of the chloromolybdenum(II) group under these conditions proceeds by the formation of an unstable substituted chloromolybdenum(II) nucleus As this group retains its identity under most conditions, it is proposed to designate it as '*M*' in formulæ

The present work strongly supports the view that the chloromolybdenum(II) group invariably possesses six groups bound to it The following are typical examples of the new compounds isolated $[M\mathrm{Cl}_4(\mathrm{C}_5\mathrm{H}_5\mathrm{N})_2]$, $[M\mathrm{Cl}_4((\mathrm{C}_2\mathrm{H}_5)_3\mathrm{N})_2]$, and $(\mathrm{H}_3\mathrm{O})_2[M\mathrm{I}_6]$ $6\mathrm{H}_2\mathrm{O}$ Compounds with compositions corresponding to the following have also been reported[4] $[M\mathrm{Cl}_4(\mathrm{H}_2\mathrm{O})_2]$, $[M\mathrm{Cl}_4(\mathrm{C}_2\mathrm{H}_5\mathrm{OH})_2]$, $\mathrm{K}_2[M\mathrm{Cl}_6]\,6\mathrm{H}_2\mathrm{O}$, $[M\mathrm{Br}_4(\mathrm{H}_2\mathrm{O})_2]$, and $(\mathrm{H}_3\mathrm{O})_2[M\mathrm{Br}_6]\,6\mathrm{H}_2\mathrm{O}$ The parent acid of the hexachloro-chloromolybdenum(II) series has been known in the crystalline form as $(\mathrm{H}_3\mathrm{O})_2[M\mathrm{Cl}_6]\,6\mathrm{H}_2\mathrm{O}$ for some time[5] It is the most soluble hexachloro-complex, the salts of this acid being sparingly soluble or completely insoluble Typical salts include those of the alkali metals, ammonium and pyridinium[4] The insoluble salts derived from large organic cations, for example, tetraethylammonium and triphenylphosphonium, have been prepared in the present work The salts of the hexabromo- and hexaiodo-acids are less well known but are undoubtedly similar to those of the hexachloro-acid The hexahalogeno-acids and their salts are rapidly hydrolysed in aqueous solution and an excess of hydrohalogenic acid must be maintained for stable solution Solvolysis of these compounds is not observed in ethanol and solubilities often prove to be much higher in this solvent

In addition to $M\mathrm{Cl}_4$, it has now been possible to prepare $M\mathrm{Br}_4$, $M\mathrm{I}_4$ and $M(\mathrm{OH})_4$ by heating the appropriate hexahalogeno-acid or hydrated chloromolybdenum(II) hydroxide *in vacuo* at 250° C As there appears to be only four ligands per chloromolybdenum(II) nucleus it is reasonable to suppose that these compounds are polymeric using some ligands for bridging between chloromolybdenum(II) groups and thus satisfying the proposed octohedral requirements However, it is interesting to note that Brosset has shown the hydrates of $M\mathrm{Cl}_4$ and $M(\mathrm{OH})_4$ to consist of discrete octahedral complexes In passing, it may be mentioned that the four simple chloromolybdenum(II) compounds referred to above are found to be hygroscopic and undergo a lightening of colour on gaining water The materials may be obtained anhydrous again by reheating *in vacuo*

Complexes of the type $[M(\mathrm{OH})_6]^{2-}$, $[M(\mathrm{H}_2\mathrm{O})_6]^{4+}$ and $[M(\mathrm{NCS})_6]^{2-}$ are of interest but attempts to prepare solid compounds of the first two have failed so far Such compounds undoubtedly exist in solution as chloromolybdenum(II) hydroxide is soluble in 2 *N* acid and 0 01 *N* alkali It has been possible to confirm the existence of $[M(\mathrm{OH})_6]^{2-}$ in solution by the *p*H titration involving the precipitation of the hydroxide by standard acid from a standard alkaline solution Fig 2 shows a typical titration curve in which two equivalents of nitric acid precipitate one of $M(\mathrm{OH})_4$ Thus chloromolybdenum(II) hydroxide dissolves in alkali to give the complex $[M(\mathrm{OH})_6]^{2-}$ The addition of $[M\mathrm{Cl}_6]^{2-}$ to a concentrated potassium thiocyanate solution gives a crystalline precipitate possessing a chloride and thiocyanate content reasonable for $K_2[M(\mathrm{NCS})_6]\,6\mathrm{H}_2\mathrm{O}$ However, the compound is soluble in water, precipitating only in excess thiocyanate, and attempts to free the precipitate from the contaminating potassium thiocyanate have not proved successful so far

The ideas expressed above might be criticized on the grounds that the chloromolybdenum(II) nucleus or its proposed co-ordination complexes are, in fact, ionic assemblages rather than covalent compounds Though this is inconsistent with the chemical data already given, there is good evidence to settle this

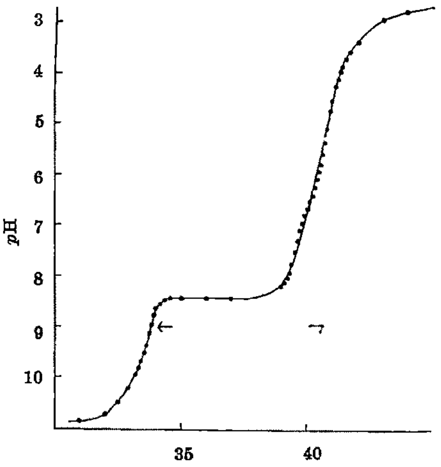

Fig 2 The precipitation of 3 29 × 10^{-4} moles of $M(OH)_4nH_2O$ occurred in the region between the arrows

point Brosset has established that the hexachloro-acid exists as $[MCl_6]^{2-}$ in ethanolic solution by an X-ray diffraction technique[3] Molecular weight determination of molybdenum(II) chloride in boiling ethanol has been found to give just over half the required value for MCl_4 [6] Under these conditions, it is very probable that some alcoholysis occurred, but ionization to a degree suggested by $M^{4+}(Cl^-)_4$ as the true constitution of molybdenum(II) chloride is ruled out Thus, in a moderately strong solvating solvent, like ethanol, the M—Cl bonds retain their identity A number of chlorine-36 exchange studies to determine the lability of the chlorine atoms in the $[MCl_6]^{2-}$ ion have been carried out in the present investigation The first experiments were carried out in 5 65 N hydrochloric acid to avoid hydrolysis The hexachloro-acid was allowed to exchange with labelled hydrochloric acid, and the complex separated from solution either by freezing out at 0° C as the crystalline acid or precipitated as the triphenylphosphonium salt. The first separation method gave a very pure material, the second gave a rapid quantitative precipitation It was found that the exchange fraction corresponded closely to the exchange of only six out of the fourteen chlorine atoms in $[MCl_6]^{2-}$ for exchange times of 2–800 min at 25° C For times of exchange less than 2 min , less than six out of fourteen chlorine atoms exchanged, but the data are inaccurate It is reasonable to conclude that all fourteen chlorine atoms in $[MCl_6]^{2-}$ are covalently bound, but the ligand chlorine atoms are much more labile than the nuclear chlorine atoms in 5 65 N hydrochloric acid The inertness of the eight nuclear chlorine atoms is striking, for on refluxing the hexachloro-acid for 1½ hr in hydrochloric acid, only six out of fourteen had exchanged

At this point it is logical to consider whether chloromolybdenum(II) should have a chemistry analogous to some mononuclear cation, or whether the resemblance is superficial It is true that if the molybdenum(II) atoms were held together by a cage of shared chlorine atoms, it may well be that the compounds resembling octahedral complexes could be isolated However, these would have the properties expected of divalent molybdenum, frequently displaying paramagnetism, ligand field spectra and a strong tendency to oxidation This is in striking contrast to what is observed, for chloromolybdenum(II) complexes are very stable to oxidation and are all diamagnetic Solution absorption spectra give no indication of ligand field spectra, only one or more bands at about 300–350 mμ, $\varepsilon \sim 3 \times 10^3$, which account for the deep yellow colour of the compounds It is possible, however, that these charge transfer bands may be superimposed on some very weak d–d transition bands Fig 3 gives the absorption curves assigned to the species $[MCl_6]^{2-}$ and $[MBr_6]^{2-}$ in 5 N hydrochloric and hydrobromic acid, respectively, and $[M(OH)_6]^{2-}$ in 0 01 N alkali It is important to bear in mind that the properties suggested above for molybdenum(II) are hypothetical as no paramagnetic molybdenum(II) compounds are known and complexes of the type $[Mo(II)X_6]$, from which $[MX_6]$ might be considered to be derived, do not exist Furthermore, mononuclear molybdenum(II) compounds are very rare (see below) If molybdenum(II) is spin-paired in chloromolybdenum(II), accounting for its diamagnetism, combination of this group with carbon monoxide-like ligands would be expected, and again this is not found There is no evidence that MCl_4 is affected by carbon monoxide at 40 atm. and 110° C or by triphenylphosphine at 200° C It is significant that among the few mononuclear molybdenum(II) complexes known, $[Mo(II)(diarsine)(CO)_3I_2]$, $[Mo(II)(diarsine)_2(CO)_2I^+]I^-$ and similar compounds have recently been prepared by Nyholm and co-workers by halogenation of tetracarbonyl-(*o*-phenylene-*bis*(dimethylarsine))molybdenum(0)[7] These compounds are diamagnetic, contain carbon monoxide-like ligands and possess ligand field spectra and co-ordination number seven Therefore, the chloromolybdenum(II) group behaves quite differently from that reasonably expected on molybdenum(II), and moreover, differently from any transition metal other than one with a d^0 configuration It is then justifiable to regard the chloromolybdenum(II) group as a particular and distinct chemical entity and not as an assemblage of atoms in a rather special geometry

The non-appearance of typical transition metal properties is not difficult to explain The intermolyb-

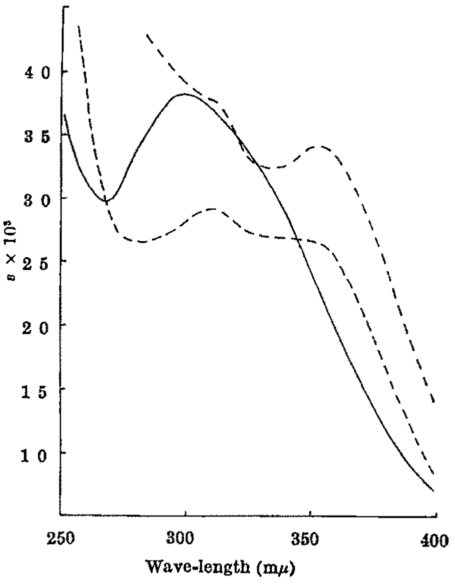

Fig. 3 — —, $[MBr_6]^{2-}$, ——, $[M(OH)_6]^{2-}$, - - -, $[MCl_6]^{2-}$

denum distance is 2 63 A. to be compared with 2 73 A for molybdenum metal, and therefore Mo–Mo bonds must exist along all sides of the Mo_6 octahedron The highly symmetrical arrangement of the Mo_6 group allows convenient consideration of the intermolybdenum bonds as delocalized and best represented by molecular orbitals For the purposes of discussion the $[MCl_6]^{2-}$ complex will be considered Each molybdenum atom is surrounded by a tetragonal pyramid of chlorine atoms, bonded probably by $d_{(x^2-y^2)}sp^3$ hybrid orbitals Of the remaining four d-orbitals, the d_{xz} and d_{yz} possess lobes directed exactly along the intermolybdenum axes and it is possible for each of four co-planar molybdenum atoms to combine one of these orbitals to give a molecular orbital system There are three such sets of co-planar atoms, each forming such orbitals The contribution of two d-electrons per molybdenum atom to forming such intermetallic bonds gives molybdenum a valency higher than the oxidation number two The disposition of the two remaining electrons in the d_{xy} and d_{z^2} orbitals must be consistent with the observed properties of chloromolybdenum(II) compounds Pairing the electrons in one of the two remaining orbitals may account for diamagnetism, but possibly not the other properties Furthermore, the proximity of the molybdenum atoms to each other also suggests that there would be some repulsive interaction between non-bonding pairs in either the d_{xy} or d_{z^2} orbitals. It is concluded that the two remaining electrons occupy the orbitals singly, and that these contribute a little more to the intermolybdenum binding by coupling their spins

Therefore, chloromolybdenum(II) can best be regarded as a compound of molybdenum(VI) employing all nine orbitals This is quite consistent with crystallographic evidence, for Brosset reports that each molybdenum atom possesses nine neighbours all closer than 2 7 A The hexavalency of molybdenum explains the absence of observable d–d transitions in spectra and the inability to form complexes with π-bonding ligands The apparent conflict of the stereochemistry of chloromolybdenum(II) with ligand field theory is removed Though the theory suggests a number of favoured arrangements for d^4 complexes, it seems unable to account for the arrangement in chloromolybdenum(II) This difficulty disappears when the compounds are recognized as d^0 complexes

In conclusion, the following points are re-emphasized Molybdenum(II) chloride complexes contain the chloromolybdenum(II) group, $(Mo_6Cl_8)^{4+}$, which functions as a nucleus for octahedral complexes of the form $[MX_6]$ The chloromolybdenum(II) group exhibits intermetallic bonding, and though the oxidation number of molybdenum is two, the valency is effectively six Consistent with the d^0 character of the molybdenum is co-ordination number nine Furthermore, this d^0 character explains the diamagnetism, absence of both ligand field spectra and complexes with π-bonding ligands of chloromolybdenum(II) compounds

I wish to acknowledge the award by the University of London of an I C I. Research Fellowship during the tenure of which this investigation was conducted, and also to express my indebtedness to Prof R S. Nyholm and Dr. J Lewis for their suggestion and support of the research

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MASSIVE INCORPORATION OF 5-FLUOROURACIL INTO A BACTERIAL RIBONUCLEIC ACID

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IN the course of studies on the correlation of the mechanisms controlling the production of cellular high-polymers, we have investigated the effects of 5-fluorouracil on the synthesis of protein and nucleic acid in several strains of *Escherichia coli* We have reported elsewhere (ref 1, and unpublished work by the same authors) on the ability of the fluoro compound to substitute, in part, for uracil in a mutant requiring this pyrimidine In the absence of uracil, the addition of 5-fluorouracil resulted in the doubling of the protein content, a slight increase in ribonucleic acid, but none in deoxyribonucleic acid, took place. In *E. coli*, strain *B*, as well as in the uracil auxotroph supplemented with uracil, the fluoro pyrimidine inhibited the synthesis of deoxyribonucleic acid completely, but permitted the formation of both protein and ribonucleic acid

The formation, in the presence of 5-fluorouracil, of several constitutive or inducible enzymes was also examined The activity of two of the enzymes, catalase and succinate dehydrogenase, increased , the induction of β-galactosidase by lactose was, on the other hand, almost entirely blocked in the presence of 5-fluorouracil The fluoropyrimidine prevented, moreover, any further rise of the β-galactosidase activity in cells that had previously been treated with the inducer or in a strain of *E coli* in which this enzyme is constitutive Other observations, soon to be published in collaboration with Drs. F Goodman and J J Saukkonen, showed that 5-fluorouracil prevented the multiplication of *T2r* bacteriophage and the intracellular synthesis of the phage nucleic acid in *E coli*, strain *B*, whereas it had less influence on the growth of *T*3

These findings, as well as the recent reports on the incorporation of 5-fluorouracil into the ribonucleic acids of animal tissues[2,3] and of tobacco mosaic virus[4], made it of interest to ascertain whether also in *E coli* the biological effects of the fluoro compound are accompanied, or caused, by its

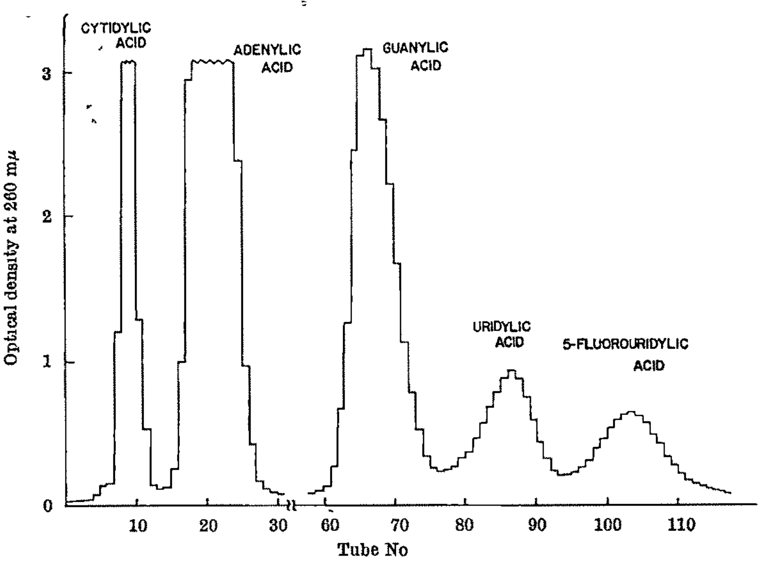

Fig 1 Elution diagram of the hydrolysate of the ribonucleic acid of *E coli*, strain *B*, formed in the presence of 5-fluorouracil 'Dowex-2-formate' (8 times), 200–400 mesh, 23 cm × 0 9 cm diameter, gradient elution (mixing chamber 500 ml water, reservoir 2 5 *N* formic acid), 7 ml fractions

introduction into the ribonucleic acid The results presented here show that a considerable amount of this uracil analogue does indeed find its way into the ribonucleic acid of the organism, where it may replace nearly one-half of the normally present uracil

To cultures (37°, glucose-salts medium, early logarithmic phase) of *E coli*, strain *B*, or of the uracil-deficient mutant 63–86, supplemented with uracil (20 μgm /ml), 5-fluorouracil (50 μgm /ml) was added and the cell suspensions were kept at 37° for varying periods If the action of the inhibitor on the uracil auxotroph was to be tested in the absence of uracil, the cells were harvested and starved before the addition of the fluoropyrimidine[1] At the conclusion of the treatment, the organisms were collected and prepared for analysis (removal of mononucleotides, lipids, etc) by procedures described previously[5]. The hydrolysis of the ribonucleic acid was carried out with 0 3 *N* alkali (30°, 18 hr) with the use of either sodium hydroxide, in which case the hydrolysate was acidified with hydrochloric acid in order to precipitate protein and deoxyribonucleic acid, or of potassium hydroxide , in the latter case perchloric acid was employed, care being taken to avoid losses through the co-precipitation of nucleotides during the removal of potassium perchlorate in the cold The ribonucleotide composition was determined by electrophoresis on filter paper or by ion-exchange chromatography

A typical elution pattern (Fig 1) shows five components, with the new nucleotide leaving the column after uridylic acid, as expected for a mixture of the 2′- and 3′-phosphates of 5-fluorouridine[3] The combined eluates of this component collected in several runs were again subjected to chromatography , the experimental conditions were as in Fig 1 except that *N* ammonium formate was used for gradient elution A single sharp peak was observed and the nucleotide identified as 5-fluorouridylic acid The hydrolysis of the compound with 72 per cent perchloric acid (1 hr , 100°) liberated 5-fluorouracil, which was identified by chromatography and spectrophotometry , the molar ratio of 5-fluorouracil to phosphorus was found to be 1 1 17 The treatment of the nucleotide with prostate phosphatase resulted in the liberation of 5-fluorouridine, which was identified by the comparison of its spectral and electrophoretic (0 1 *M* borate buffer of *p*H 9 2 [6]) properties with those of the authentic nucleoside The ratio of 5-fluorouridine to phosphate released by the enzymic hydrolysis was 1 1 1 That the nucleotide consisted of a mixture of the 2′- and 3′-phosphates of 5-fluorouridine and had, therefore, formed part of a polynucleotide, was shown by its behaviour towards 3′- and 5′-nucleotidases It was not attacked by the 5′-nucleotidase of Russell's viper venom, whereas 3′-nucleotidase[7] hydrolysed about 60 per cent of the nucleotide to fluorouridine within 20 hr 5-Fluorouridylic acid has its absorption maximum at 268 mμ in 0 01 *N* hydrochloric acid with a molar extinction coefficient of 9,400 , the absorbance ratios in the same solvent are A_{250}/A_{260}, 0 64 , A_{280}/A_{260}, 0 82 , A_{290}/A_{260}, 0 32

The nucleotide composition of the ribonucleic acid synthesized, both in the presence and the absence of 5-fluorouracil, by the two *E coli* strains under investigation is shown in Table 1 It will be seen that one-quarter to nearly one-half of the nucleic acid uracil can be replaced by the fluoropyrimidine This takes place without an essential disturbance of the equality of the molar sums of 6-amino and of 6-keto nucleotides[10] The large quantities of 5-fluorouracil built into the ribonucleic acid of strain *B* offer a convenient method for the preparation of the 2′-, 3′-, and 5′-phosphates of 5-fluorouridine It is noteworthy that 5-fluorouridylic acid was also found in the ribonucleic acid of the uracil-requiring mutant incubated with the fluoropyrimidine in the absence of uracil, although the amount of nucleic acid synthesized under these conditions is slight (ref 1, and unpublished work by the same authors) Owing to the relatively small number of analyses it is not yet clear what importance should be attached to the fluctuations in nucleotide proportions recorded in Table 1 , nor is it yet known whether 5-fluorouracil is incorporated preferentially into any particular fraction of the total ribonucleic acid or into certain positions on the polymer chain

In contrast to the known metabolic fate of uracil, we have found no indication that 5-fluorouracil gives rise also to a 5-fluorocytidylic acid component of the nucleic acid Preliminary evidence would, in fact, seem to speak against the presence of the latter fluoro nucleotide, at least in amounts comparable to those of 5-fluorouridylic acid Neither elution peak nor chromatographic zone corresponding to 5-fluorocytidylic acid was seen , the spectra of the separated nucleotides showed no evidence of such a contaminant Moreover, orienting experiments on the uptake of uracil-2-^{14}C by the ribonucleic acid of the uracil auxotroph exclude the occurrence of appreciable quantities of 5-fluorocytidylic acid As shown in Table 2, 5-fluorouracil depresses the incorporation of

Table 1 NUCLEOTIDE COMPOSITION OF RIBONUCLEIC ACID OF *E coli* STRAINS

No	Specimen*	Analytical procedure†	Moles per 100 moles nucleotide in ribonucleic acid				
			Adenylic acid	Guanylic acid	Cytidylic acid	Uridylic acid	5-Fluorouridylic acid
1	Strain *B*, normal	I	26 3	29 6	25 1	19 0	—
2	Strain *B*, treated with 5-fluorouracil, 21 hr	II	23 1	30 4	25 2	11 4	9 8
3	Uracil auxotroph 63–86, normal	III	23 7	32 6	23 0	20 8	—
4	Uracil auxotroph 63–86, treated with 5-fluorouracil, in the presence of uracil, 3 hr	III	24 6	30 4	24 3	15 9	4 8
5	Uracil auxotroph 63–86, treated with 5-fluorouracil, in the absence of uracil, 16 hr	II	23 3	32 7	22 5	17 4	4 0

* The figures for No 1, averages of many determinations, are taken from a previous publication (ref 8), those for No 3 are based on several hydrolysis experiments Specimens No 2, 4 and 5 were single preparations Preparations of strain 63–86 treated with 5-fluorouracil, in the presence of uracil, for 1 and 2 hr, gave results very similar to those reported for specimen No 4

† The following procedures were employed (I) chromatography on filter paper in the isobutyrate solvent (ref 8), (II) separation of nucleotides liberated by sodium hydroxide on 'Dowex-2-formate' columns by gradient elution with formic acid (ref 3), (III) separation of nucleotides liberated by potassium hydroxide through electrophoresis on filter paper in 0 02 *M* citrate buffer of *p*H 3 5 (ref 9) In the last-mentioned system uridylic and 5-fluorouridylic acids migrate together The fluoronucleotide was, therefore, determined separately by electrophoresis in 0 1 *M* borate buffer of *p*H 9 15, in which it migrates as the fastest component (ref 4), and the estimates of uridylic acid were suitably corrected

uracil into the uridylic acid, but not its utilization for the cytidylic acid, of the ribonucleic acid of the mutant It may also be mentioned that we have encountered no indication of the entrance of 5-fluorouracil into the deoxyribonucleic acid of *E coli*

Table 2 EFFECT OF 5-FLUOROURACIL ON INCORPORATION OF URACIL-2-^{14}C INTO *E coli* RIBONUCLEIC ACID

Exponentially growing cells of the *E coli* mutant 63–86 were washed and starved of uracil (ref 1) After the addition of uracil-2-^{14}C (20 μgm /ml, specific activity 25,000 c p m /μmole) the preparation was divided into two equal parts one of which received 5-fluorouracil (50 μgm /ml) During the subsequent incubation at 37° C for 3 hr, equal amounts of ribonucleic acid were formed in both preparations The radioactivity found in the purine nucleotides and in 5-fluorouridylic acid amounted to less than 5 per cent of that incorporated into the pyrimidine nucleotides The results are reported per ml of cell suspension

Specimen	Uracil-2-^{14}C incorporated (μm moles per ml)		Incorporation ratio, uridylic acid to cytidylic acid
	Uridylic acid	Cytidylic acid	
Normal	25 1	29 5	0 85
Treated with 5-fluorouracil	14 3	30 0	0 48

We are indebted to Dr J A Aeschlimann, Hoffmann-La Roche, Inc, Nutley, N J, for specimens of the fluoro compounds used in these studies. The uracil-requiring mutant, originally isolated by Prof B D Davis, of Harvard University, was given us by Dr E Borek We are grateful to Dr J J Saukkonen for helpful discussions and to Mr R L Cooper for technical assistance The work was supported by grants from the United States Public Health Service and the National Science Foundation

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MEASUREMENTS OF TEMPORAL ADAPTATION TO SPATIAL DETAIL VISION

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THERE is neurophysiological and psychological evidence[1-3] that temporal as well as spatial adaptation processes are involved in visual perception From this we argued that after the presentation of a new visual pattern a certain time may be required for a viewer to recognize spatial detail in this new pattern

A quantitative measure of the perceptual time delay versus the size of detail would be a significant design parameter for a variety of control and communication systems involving the human sense of vision. Tachistoscopic visual recognition tests and reaction time measurements have been reported[4,5], but we think that these have a different significance, because the object, and thus the design, of the experiments are different.

The idea behind our experiments was that, if the viewer requires a definite adaptation time to perceive spatial detail in a newly presented visual scene, it should be possible to measure this effect by presenting the new scene in such a way that the detail size is decreased progressively in time after the instant of presentation In other words, the new scene is 'blurry' when it is presented to the viewing subject and is made increasingly 'sharper' as function of time If this temporal increase in objective sharpness occurs faster than the subjective adaptation to the perception of detail, the viewer will not notice the effect If, however, the temporal adaptation process of the viewing subject proceeds faster than the objective increase in sharpness, it will be noticed by the subject that the scene had been blurred initially It will be recognized that this approach contains certain elements of transient response testing of electrical systems where the response to a finite transition (in time and amplitude) is given by the convolution of excitation and transfer function Hence, for our tests, we argued that the finite temporal increase in sharpness will not be noticed, when the perceptual time response to it is not 'noticeably' slower than what it would have been to a scene which was sharp from the instant of its presentation (response to an ideal stimulus).

Because the 'sharpness' of a picture can be conveniently varied (along the horizontal dimension) by varying the band-width of a television picture signal using a variable low-pass filter, television-type presentation was chosen This also facilitated rapid change-over from one scene to another by electronic means The test scenes were stationary (slides) while between presentations of these was displayed an 'interlude' of a normal television programme without sound received from local stations This, we found, prevented staring at the display area, provided relaxed viewing conditions with no specific bias towards any one fixation point and introduced a close similarity to actual viewing in everyday situations

The experimental conditions were as follows Television pictures in accordance with the C C I R Standard (625/50/25) having a maximum signal band-width of 5 Mc /s. were displayed on a studio monitor of 9 in × 12 in. picture dimensions The monitor was surrounded by a flat grey surface, 48 in × 68 in Indirect ambient lighting was used in the test area The brightness of the surround was 0 2 foot-lambert, picture peak white 4 foot-lambert and picture black 0 1 foot-lambert (measured with *SEI*-Photometer) Two different viewing distances were used, one at four times, the other at eight times, picture height Correspondingly, the maximum picture dimension (width) had a subtended angle of 19° and 9° 30′ for the two distances and minimum detail size for any signal band-width of B Mc /s is given by 11 4/B and 5 7/B minutes of arc respectively

By means of a voltage-controlled continuously variable low-pass filter[6] the signal band-width was varied from a minimum B_m Mc /s at the time of scene change-over, $t = 0$, to the system band-width of $B_s = 5$ Mc /s at $t = T$ in accordance with the following time function

$$B(t) = B_m \exp\left(\frac{t}{T} \log \frac{B_s}{B_m}\right) \text{ Mc /s}, \quad 0 < t < T$$

Thus the minimum detail size in minutes of arc subtended angle varied for the two viewing distances as

$$S(t)_4 = \frac{11\ 4}{B(t)} \text{ and } S(t)_8 = \frac{5\ 7}{B(t)}$$

The minimum band-width B_m (degree of blurriness) and the recovery time T as well as the test slide were preset by the experimenter without the subject knowing the conditions After being prompted by the experimenter the subject pressed a control button by which the interlude scene was replaced by the test scene The equipment was controlled so that change-over took place during the suppression interval (of approximately 1 5 msec) between television frames following the pressing of the button This instant being time $t = 0$ was also the beginning of the recovery of the filter from the preset minimum to full system band-width, which caused the increasing of the objective picture sharpness over the interval $0 < t < T$ Shortly afterwards, the subject announced by 'Yes' or 'No' whether a blurring of the picture was 'seen' or not The test slide display was then changed back to the interlude by the experimenter before the next experimental condition was established An average of not more than 150 decisions were made by each subject during a single session in order to prevent tiring The sequence of the three experimental parameters was selected from a table of random numbers

In tests of this nature it is desirable to have approximately equal frequencies for 'Yes' and 'No' We therefore carried out exploratory tests at a viewing distance of four times picture height by which we intended to find values for B_m for which the decisions went from 100 per cent 'No' to 100 per cent 'Yes' when T was varied For B_m ranging from 0 28 to 4 Mc /s and T from 20 to 2,600 msec , full transitions from 100 per cent 'No' to 100 per cent 'Yes' could only be obtained for B_m less than 1 Mc /s At this particular setting the percentage 'No' never fell below 60 per cent and seemed to vary in an unsystematic way for recovery times exceeding 1 sec We therefore concentrated on the two values of 0 28 and 0 5 Mc /s for B_m, corresponding to 40 6 and 22 8 minutes of arc for the maximum detail size at four times picture height and 20 3 and 11 4 minutes of arc at eight times picture height viewing distance The minimum detail size for the two distances and $t > T$ was 2 28 and 1 14 minutes of arc For each setting of B_m eight different recovery times were used, being $50 < T < 2{,}600$ msec and $40 < T < 2{,}080$ msec for $B_m = 0\ 28$ and $B_m = 0\ 5$ Mc /s respectively

Three different test slides were displayed One of these depicted a group of three children, the second an aerial view of a city and the third a stone hut, all three contained fine detail and sharp contours of good contrast but different distribution over the picture area Since the experiment was not concerned with a semantic recognition, the pictorial content of the slides was of less significance than the availability of detail to which the subject's perception would adapt itself

Four male subjects belonging to the staff of the Laboratories were tested They were all familiar with the experiment and the appearance of the reduced detail presentation. Therefore, they may be classed as skilled and critical observers

The 'percent not seen' ('No') for each experimental condition were computed taking the decisions of all subjects on all test slides together The resulting

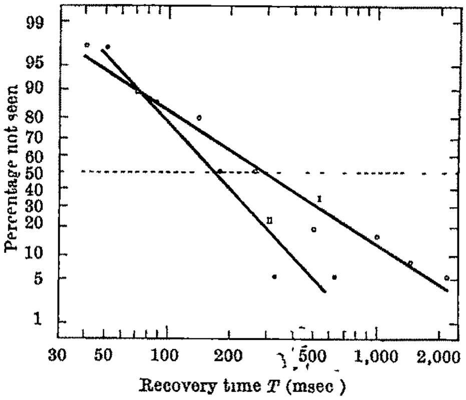

Fig 1 Percentage not seen versus recovery time Viewing distance, four times picture height I, (○ – ○) $B_m = 0\ 5$ Mc /s, $S_{\max} = 22\ 8$ min of arc, II, (● – ●), $B_m = 0\ 28$Mc /s , $S_{\max} = 40\ 6$ min of arc

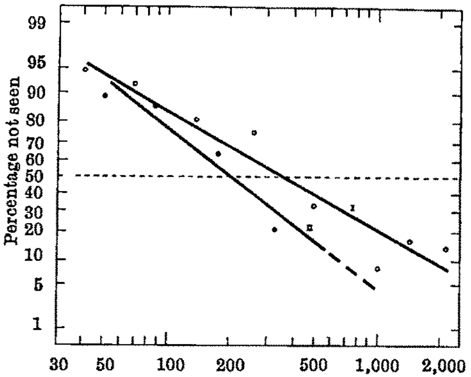

Fig 2 Percentage not seen versus recovery time Viewing distance, eight times picture height I, (○ – ○) B_m = 0 5 Mc /s , S_{max} = 11 4 min of arc , II, (● – ●) B_m = 0 28 Mc /s , S_{mx} = 20 3 min of arc

experimental points were fitted to a normal distribution versus the logarithm of recovery time (T) as shown in Figs 1 and 2, using the method of least squares Each point represents 36 decisions The permissible recovery times for which the initial lack of sharpness in detail was not seen in 50 per cent of the presentations are listed with the respective experimental conditions in Table 1

Although within the same viewing distance the permissible recovery time increases approximately in the same ratio as the initial detail size decreases, for the doubling of the viewing distance (that is, halving of detail size for the same B_m) the recovery time increases only by a factor 1 25

From what is known about human sensual phenomena we cannot expect linear behaviour over any extended range of inputs and stimulus conditions Hence we consider it unjustified to attempt an extrapolation from the restricted data at our disposal at this time However, the main conclusions which we may draw from the results of the experiment are that a certain time is required after the presentation of a new and remaining visual display before the perception threshold for fine detail is reached, and that due to this effect it is possible to expand the time interval within which detail in changing complex visual displays is offered to the viewer without noticeably interfering with the normal perception process

Table 1

Viewing distance (picture height)	4 times		8 times	
Minimum detail (min of arc)	2 28		1 14	
Maximum detail (min of arc)	40 6	22 8	20 3	11 4
Recovery time (msec) for 50 per cent 'No'	160	290	200	360

It must be left to further extended experiments to attempt a determination of the functional relationships between the relevant parameters

We are indebted to the Supervising Engineer, Research, Postmaster-General's Department of Australia, for permission to publish the material contained in this communication

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EFFECT OF OXYGEN TENSION ON HÆM AND PORPHYRIN BIOSYNTHESIS

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THE adaptive synthesis of cytochromes in aerobic and anaerobic conditions of culture is well known[1]. It has been shown by one of us[2] that as the oxygen tension in the culture medium is increased, the synthesis of cytochrome a_2 by *Aerobacter aerogenes* increases to a maximum, and then decreases when still higher oxygen tensions are applied The maximum was reached when the oxygen concentration in the medium was of the low order of 0 1 *M* It was suggested that a self-regulatory mechanism may operate, the formation of cytochrome a_2 being controlled in accordance with the respiratory requirements imposed by [illegible] prevailing oxygen tension

It occurred to [illegible] that prosthetic group synthesis might be affected by the oxygen tension The prosthetic group of cytochrome a_2 is an iron-chlorin[3], and nothing is yet known about the biosynthesis of this cytochrome or its prosthetic group It has now been found, however, that the biosynthesis of protoporphyrin and hæm, in chicken erythrocyte preparations *in vitro*, appears to be regulated by oxygen tension

Whole blood (25 ml) from normal chickens was shaken with glycine (final concentration 0 056 *M*) and 1 mgm each of heparin, penicillin and streptomycin, at 38° C The gas mixtures all contained 5 per cent carbon dioxide and the relevant concentration of oxygen , nitrogen was used as diluent The mixtures were made in aspirators, and by displacement with water were bubbled through the incubation mixture at the rate of 2 1 /hr The conical incubation flasks were closed with Bunsen valves, and frothing was controlled by a few drops of octanol When washed cells were used, 25 ml of blood was centrifuged and the serum and the 'buffy coat' removed The erythrocytes were washed three times with isotonic sodium chloride and resuspended in isotonic sodium chloride to a final volume of 25 ml Substrates and antibiotics were then added, and incubations carried out, as described for whole blood Porphyrin and hæm synthesis were determined as described by Dresel and Falk[4]

As shown in Fig 1, the synthesis of copro- and proto-porphyrins and hæm in this system is regulated by oxygen tension The synthesis of protoporphyrin and hæm is related linearly to time under these conditions (cf Fig 3, and Dresel and Falk[4])

It is not possible, without further experiments, to say whether or not the optimum oxygen tension for the synthesis of hæm is the same as that for protoporphyrin The situation is complicated by the effects of oxygen upon the incorporation of iron into protoporphyrin The tissue-catalysed combination of ferrous iron with protoporphyrin is inhibited by oxygen[6], and the liberation of iron from storage in liver ferritin is promoted by low oxygen tensions[7] Such factors may contribute to the very great inhibition of hæm synthesis at the highest oxygen tensions (Fig 1)

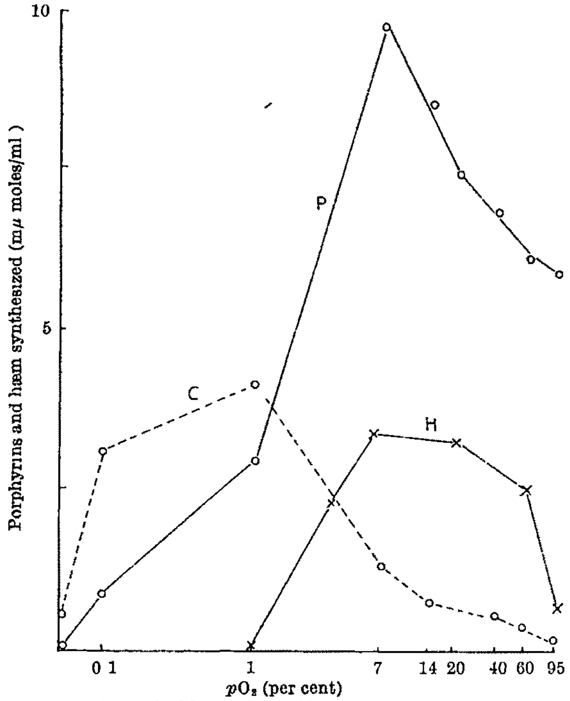

Fig 1 The control by oxygen of hæm and porphyrin synthesis from glycine in whole chicken blood Whole blood (25 ml) was incubated for 8 hr , as described in the text *P*, protoporphyrin , *C*, coproporphyrin , *H*, hæm

When the erythrocytes were washed three times with isotonic sodium chloride before incubation with glycine, the curve for protoporphyrin formation was found to be similar in form to that shown in Fig 1, but maximum synthesis was depressed by about 80 per cent (Fig 2)

That the inhibition of protoporphyrin formation by higher oxygen tensions is reversible is shown in Fig 3 We have not been able to demonstrate marked degradation of protoporphyrin at 'inhibitory' oxygen tensions

During the biosynthesis of porphyrins, 'aerobic' reactions are known to be required for the formation of δ-aminolævulic acid, but not again until near the end of the biosynthetic pathway, for the final formation of the vinyl side-chains, and possibly also for the oxidation of a porphyrinogen to the porphyrin level[4,5] The rising slopes in Fig 1 reflect these requirements for oxygen, it appears that much lower oxygen tensions suffice for reactions prior to coproporphyrin formation than for the formation of protoporphyrin If the decreased amounts of protoporphyrin found at higher oxygen tensions are not due to degradation reactions, they would appear to be due to an inhibition by oxygen of some step in the synthetic pathway As pointed out above, this inhibition is reversible, and it must lie far back in the pathway because coproporphyrin synthesis also is decreased at those high levels of oxygen (Fig 1) at which protoporphyrin synthesis is decreased

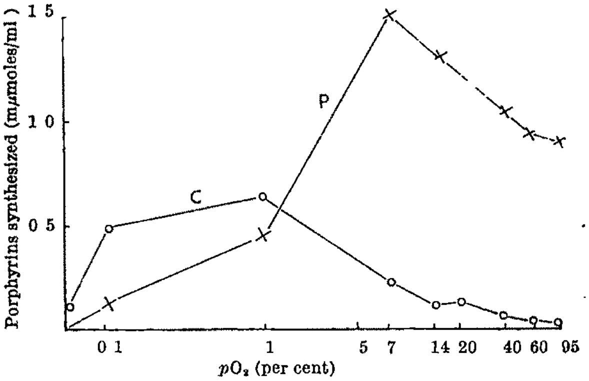

Fig 2 The control by oxygen of porphyrin synthesis from glycine in washed chicken erythrocytes The cells from 25 ml blood were washed and incubated for 10 hr , as described in the text *C*, coproporphyrin , *P*, protoporphyrin No protoporphyrin was formed in the complete lack of oxygen

It appears possible that the control of porphyrin synthesis by oxygen tension may play an important part in cytochrome adaptation in bacteria, though the production of some cytochromes by obligate anaerobes must be considered There is also evidence[8] that the synthesis by micro-organisms of some colourless enzymes is controlled by oxygen tension

It is interesting to relate the present findings to animal physiology The stimulatory effect of anoxia upon erythropoiesis in higher animals[9] and in Crustacea and other invertebrates[10] is well known, and it has also been shown that high tissue-oxygen tensions lead to decreased erythropoiesis[11] In physiological studies, it has been difficult to separate the effects upon erythropoiesis of oxygen tension from those of endocrinological or other 'plasma'

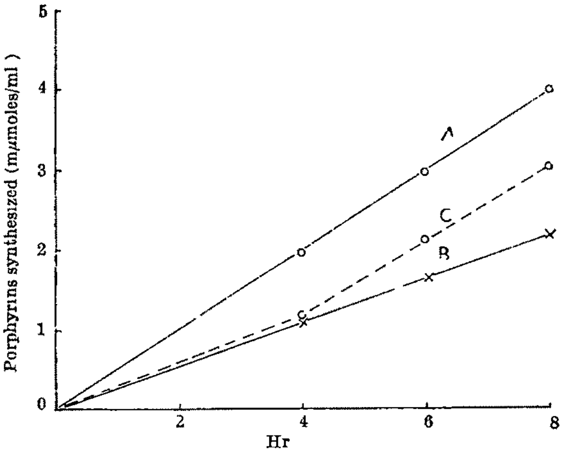

Fig 3 The reversibility of the inhibition by high oxygen tension of protoporphyrin synthesis Whole chicken blood was incubated as described in the text Curve *A*, 5 per cent oxygen , curve *B*, 95 per cent oxygen , curve *C*, 95 per cent oxygen for 4 hr , then 5 per cent oxygen for 4 hr

factors[9] The present experiments indicate that there is an oxygen effect exerted directly on a step or steps in the biosynthetic pathway to hæm In studies *in vitro* of bone marrow from rabbits damaged by X-irradiation, and of normal marrow[12], it has been demonstrated that hæm synthesis precedes that of globin , oxygen tension, by limiting directly the synthesis of hæm, may be expected to limit hæmoglobin synthesis That the rate of maturation of erythrocyte precursors *in vitro* increases with oxygen tension to a maximum and falls with further increases of oxygen has been demonstrated[13], and it appears possible that maturation of these cells may be linked to hæmoglobin synthesis

Since the above was written, Lascelles[14] has shown that the formation of bacteriochlorophyll in *Rhodopseudomonas spheroides*, incubated in the dark, reaches a maximum at a pO_2 of about 6 per cent and is depressed at higher oxygen tensions The formation of δ-aminolævulic acid, and the conversion of this to porphobilinogen, were both found to be sensitive to oxygen tension in *R spheroides* We have not investigated the sensitivity of these particular reactions to oxygen in chicken erythrocyte preparations, but we have clear evidence (to be published) that some reaction after the formation of porphobilinogen and prior to the formation of uroporphyrin is inhibited by oxygen tensions higher than about 7 per cent A preliminary report of this work has been given[15] and it will be described in detail elsewhere It thus appears that in tetrapyrrole biosynthesis, oxygen may control a number of sensitive steps which could vary both qualitatively and quantitatively from tissue to tissue

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POSSIBLE ROLE OF HIGHER PROPRIOCEPTIVE CENTRES IN THE PERCEPTION OF VISUAL SPACE AND IN THE CONTROL OF MOTOR BEHAVIOUR

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THE variability of oriented motor acts may lead to the assumption that the transformation of proprioceptive impulses into signals for the appropriate regulation of a movement going on greatly depends on temporary changes produced by the conditioning stimulus in the higher centres to which they are flowing Admitting that orientation in space is mainly based on ontogenetic experience, we are led to suppose that the 'Pavlov feedback'[1]—the temporary connexions of the higher proprioceptive centres—play an important part in the organization of the perception of space

This view is not generally accepted Thus, in visual space perception theory, Sherrington's concept[2] identifying the 'muscle sense' of the eyes with the inflow of impulses from the sensory nerve endings in the extrinsic eye muscles is opposed by the generally accepted Helmholtz's theory[3] affirming that we evaluate the direction of our sight on the basis of "the innervation impulses we must apply to transfer the eye in the intended position"

According to a recent suggestion[4], the normal human perception of space "is organized on the conservative principle of a null-hypothesis" and should require no analysis in terms of specific neural events Such a rather paradoxical view will scarcely satisfy the physiologists interested in the investigation of nervous mechanisms subserving normal life functions

Now, from Helmholtz's typical 'outflow' theory it would follow that for every eye rotation a corresponding innervation pattern is quantitatively 'predetermined' by the 'sense of innervation' Hence, as the eyes in their movements (especially horizontal) constitute a system with constant mechanical load, equally directed eye fixation movements of a subject in equal conditions ought to follow the same course

To study eye rotations under the action of the 'muscle sense', conditioned fixation movements have been systematically investigated in 14 normal subjects In response to the conditioning sound stimulus (400/sec , 30 db above audibility threshold, applied during 1½ sec) the subjects had to turn their eyes in total darkness and to maintain them in the directions in which formerly visible points appeared and were fixed A total of 14,000 large-scale electrooculographic records were examined, and the results analysed statistically

Previously, it has been shown[5] that conditioned eye 'muscle sense' has significant directional power, for, in the mean, 40 per cent of all conditioned eye movements were found to be as precisely directed towards the goal as fixation movements to visible objects, and, once attained, a given position of the eyes was further as exactly maintained in complete darkness

It was no less significantly demonstrated (Fig 1) that even in a series of successive trials, the saccadic movements of the same subject's conditioned eye fixation, transferring the line of regard into one and the same exact final direction, nevertheless differ essentially one from each other as regards characteristics and composition of the saccade, and namely as

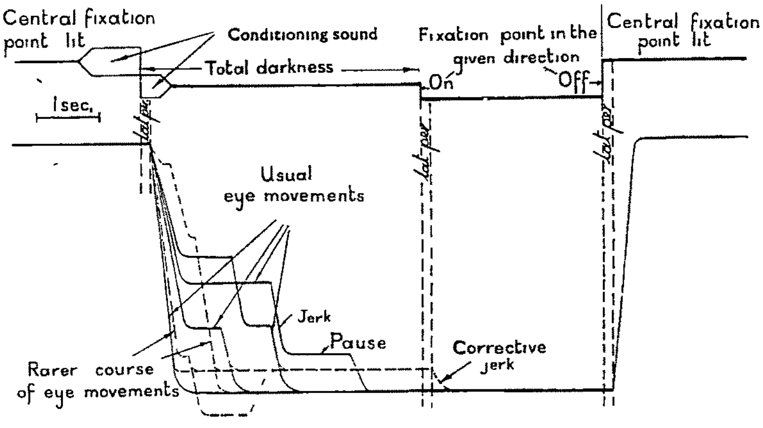

Fig 1 Representative scheme showing typical variability of equally directed precise (——) or imprecise (– – –) conditioned eye fixation movements in successive trials Abscissae time, ordinates eye displacement during trials From more than 2,000 records of conditioned eye movements in the dark of six subjects, in various given directions from 6° 20′ to 35° off the centre in the horizontal plane Optically elicited and conditioned changes in fixation are preceded by latent periods of about 0 15 sec lat per = latent period

to (*a*) the number of single eye jerks in it (for example, from 1 to 3, and up to 6 jerks in the total saccade), (*b*) the size of these jerks (varying, most generally, from 30 to 100 per cent of the total fixation movement, and in extreme cases from 15 per cent up to 120 per cent of its total size), (*c*) the duration of pauses between successive jerks in the saccades (habitually, from 0 04 to 0 7 sec , and up to 1 92 sec), (*d*) the angular speed of the eye movement in jerks of equal size (from 60 to 140 per cent, and not infrequently up to 200 per cent of its mean value) In some cases reversals have been observed in the usual succession of diminishing jerks, and in some other cases excessive jerks have been recorded, followed by corrective jerks in the opposite direction

Such a fundamental variability of the composition of equally directed saccadic fixation movements characterizes conditioned eye rotations of every size in the horizontal plane as well as in vertical and in diagonal planes We may conclude that conditioned eye movements of equal total size and direction, just like motor acts of the organism as a whole, are generally produced by essentially variable sequences of innervation impulses, which is inconsistent with the innervation theory On the other hand, the now well-known proprioceptors[6] of the extrinsic eye muscles are the only sensory organs firing during eye rotations in total darkness, and this proprioceptive feedback is used to bring the position of the eyes into accordance with the temporary central changes brought about by the conditioning stimulus Thus the observations strongly support the hypothesis that the 'muscle sense' of the eyes is mainly controlled by temporary changes in the higher proprioceptive centres, and it must be noted that such a mechanism would form a physiological basis for visual illusions arising in cases of dissociation between the actual eye position and the evaluation of the line of regard, which in fact depends on conditioned fixation reflex training

Because of the restriction of nerve connexions engaged and the constancy of mechanical load during movement, the conditioned eye fixation reflex may be considered as a simple physiological model of more complicated motor behaviour acts

It appears that to remove apparent contradictions between 'peripheral' theories of behaviour control (like Sherrington's) and 'central' theories (like Helmholtz's), Pavlov's theory must be applied to sensory arcs of the conditioned reflex Fig. 2 represents a hypothetical scheme based on Pavlov's concept of temporary cerebral kinæsthetic feedback The external stimuli, having formerly coincided with reactions fulfilled and re-inforced, on eliciting a reaction by the way of its effectory centre, simultaneously produce in the higher proprioceptive centres changes just like those which, beforehand, became reinforced at the fulfilment of the reactions During the course of the reaction, the impulses ascending to the higher proprioceptive centres from the sensitive endings in the effectory organs are constantly re-codified according to the functional state of these centres and, being thus transformed into signals of correction, take part in the regulation of the reaction until its fulfilment and repeated reinforcement Thus, it appears that behaviour acts remain on the whole adequately directed, because of the regulation during their course of the efferent nerve supply by the higher proprioceptive centres, according to changes brought to these centres by conditioning stimuli

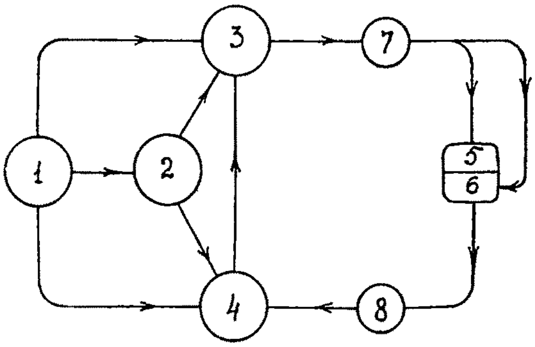

Fig 2 Hypothetical scheme of the central 'sensory' control of behaviour, 1, cortical representation of the conditioning stimulus, 2, cortical centre of the unconditioned reaction, 3, cortical effectory and 4, cortical sensory centre of the conditioned reaction, 5, effectory organ and 6, sensory endings in it, 7, 8, subcortical centres Arrows show the supposed directions of the main innervation flows engaged

It is only in the frame of the conditioned changes in the higher sensory centres that the afferent impulses from the effectory organs get their full meaning for the organism 'Muscle sense' arises from co-operation and mutual control, as behaviour acts are going on, of certain sensory events of external and internal origin, this co-operation and mutual control being rendered possible by the conditioned reflex mechanisms Thus, the mechanisms of elaboration of temporary changes in the higher proprioceptive centres may be regarded as probably the more general physiological basis of psychic space perception phenomena

[1] Pavlov, I P , *Psychological Rev* , 39, 97 (1932)
[2] Sherrington, C S , *Brain*, 41, 332 (1918)
[3] Helmholtz, H v , "Handbuch der physiologischen Optik", 3 Aufl (Voss, Leipzig, 1910)
[4] MacKay, D M , *Nature*, 181, 507 (1958)
[5] Gurevitch, B Kh , *Doklady Akad Nauk, SSSR* , 115, 829 (1957).
[6] Cooper, S , and Daniel, M. P., *Brain* 72, 1 (1949).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 30

Royal Society (at Burlington House, Piccadilly, London, W 1), at 2 30 p m —Anniversary Meeting

Institute of Metal Finishing (in the Canterbury Room of the Charing Cross Hotel, London, W C 2), at 2 45 p m —Mr A A B Harvey "The Role of the Scientific Society" (Presidential Address)

University College (in the Physiology Theatre, Gower Street, London, W C 1), at 5 p m —Prof E P Kennedy (University of Chicago) "The Biosynthesis of Complex Lipids" * (First of two lectures in Biochemistry Further lecture on December 7.)

Royal Institution, Library Circle (at 21 Albemarle Street, London, W 1), at 5 30 p m —Dr L Pearce Williams "Faraday Through His Manuscripts"

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 8 30 p m —Prof C von Furer-Haimendorf "Sherpas of Eastern Nepal"

Tuesday, December 1

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 1 15 p m —Prof R E D Bishop "Vibration Problems in Engineering" *

Institution of Electrical Engineers, Measurement and Electronics Sections (at Savoy Place, London, W C 2), at 5 30 p m —Dr L Essen, Mr J V L Parry and Mr J McA Steele "Frequency Variations of Quartz Oscillators and the Earth's Rotation in Terms of the N P L Cæsium Standard"

University of London (at Imperial College of Science and Technology, London, S W 7), at 5 30 p m —Prof H K Porter "Physiology has No Frontiers" (Inaugural Lecture)

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 5 30 p m —Dr J L Gowans "The Lymphocyte" * (Twelfth of fifteen lectures on "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation Further lectures on December 3, 8, 10)

Plastics Institute (at the Wellcome Building, 183–193 Euston Road, London, N W 1), at 6 30 p m —Mr M R E Ashenden 'Plastics and the Law"

Royal Aeronautical Society (at 4 Hamilton Place, London, W 1), at 7 p m —Dr I M Hall "Transonic Flow Over Swept Wings"

Wednesday, December 2

Institute of Petroleum (at 61 New Cavendish Street, London, W 1), at 5 30 p m —Mr J Marechal and Mr P de Radzitsky "Potentialities of Urea in Dewaxing Middle and Heavy Distillates"

Institute of Information Scientists (at the Berners Hotel, 10 Berners Street, London, W 1), at 6 p m —Discussion on "Languages in Information Work—To What Extent is Competence in a Foreign Language an Essential Qualification for an Information Scientist?"

Wednesday, December 2—Thursday, December 3

Iron and Steel Institute (in the Great Hall, Caxton Hall, Caxton Street, London, S W 1, and the Hoare Memorial Hall, Church House, Great Smith Street, London, S W 1), at 9 30 a m daily—Autumn General Meeting

Thursday, December 3

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 1 15 p m —Mr P R Bell "The Origin of Indian Corn" *

Royal Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Mr F H C Edgcombe and Prof R G. W Norrish, F R S "A Study of the Mechanism of Photochemical Electron Transfer Processes in Solution", Mr I M Dawson and Mr E A C Follett "An Electron Microscope Study of Synthetic Graphite"

Institute of Marine Engineers (joint meeting with the Institute of Naval Architects, in the Weir Hall, 10 Upper Belgrave Street, London, S W 1) at 4 45 p m —Prof G Aertssen "New Sea Trials on the Sandblasted *Lubumbashi*"

University of London (at the London School of Economics and Political Science, Houghton Street, London, W C 2), at 5 p m —Dr E R Leach "Rethinking Anthropology"* (Malinowski Memorial Lecture)

Royal Society of Arts, Commonwealth Section (at John Adam Street Adelphi, London, W C 2), at 5 15 p m —Mrs Mildred Valley Thornton "Indians of British Columbia"

Institution of Electrical Engineers (at Savoy Place, London, W C 2) at 5 30 p m —Mr C B B Wood and Mr I J Shelley "The Transmission of News Film over the Trans-Atlantic Cable"

Society of Chemical Industry, Microbiology Group (joint meeting with the Society for Applied Bacteriology, at the Royal Society of Medicine, 1 Wimpole Street, London, W 1), at 6 15 p m —Dr F Brown "Infective Ribonucleic Acid from the Virus of Foot-and-Mouth Disease"

Friday, December 4

Institution of Electrical Engineers, Medical Electronics Discussion Group (at Savoy Place, London, W C 2), at 6 p m —Discussion on "Nuclear Magnetic Resonance", opened by Dr N Sheppard and Dr R E Richards

Society of Dyers and Colourists (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 6 p m —Mr R C Oakley "Dyeing of Ribbons", Mr R Woods "Dyeing of Carpet Yarns"

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m —Dr H A Thomas "Electronic 'Brains'"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturers or Assistant Lecturers (suitably qualified graduates, with some experience in any of the branches of electrical engineering) in the Department of Electrical Engineering—The Registrar, The University, Manchester 13 (November 21)

Lecturer in Telecommunication, to undertake undergraduate and postgraduate teaching and to supervise research involving information analysis and experimental work, including the human element—Head of the Electrical Engineering Department, Imperial College of Science and Technology, Exhibition Road, London, S W 7 (November 24)

Lecturer (with a degree in psychology or equivalent and experience of teaching and clinical work) in Educational Psychology—The Registrar, University College, Swansea (November 28)

Senior Lecturer and a Lecturer (preferably with a major interest in applied thermodynamics or applied mechanics, especially the theory of machines) in Engineering (Mechanical)—The Registrar, The University, Manchester 13 (November 28)

Senior Lecturer, Lecturer, and an Assistant Lecturer in the Department of Mechanical Engineering—The Registrar, Royal Technical College, Salford, Lancs (November 28)

Assistant Lecturer (Demonstrator) in Anatomy to undertake teaching and research , and a Research Assistant (with an honours degree in zoology or medical sciences, and preferably a knowledge of German) in the Department of Anatomy, for work mainly on the central nervous system—The Secretary, University College London, Gower Street, London, W C 1 (November 30)

Lecturer in Applied Mathematics at Victoria University of Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (New Zealand, November 30)

Research Officer (with veterinary qualifications), for studies on virus of foot-and-mouth disease in farm animals—The Secretary, Research Institute (Animal Virus Diseases), Pirbright, Surrey (November 30)

Senior Lecturer in Chemistry at Victoria University of Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (New Zealand, November 30)

Research Assistant (with a first- or second-class honours degree in chemistry, or alternatively, graduate member of the Royal Institute of Chemistry) in Chemistry—The Principal, Coventry Technical College, Butts, Coventry (December 1)

Lecturer (with experience in either heavy electrical machinery or of power transmission and distribution) in Electrical Engineering—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (December 4)

Assistant or Associate Professor of Applied Mathematics—The Chairman, Department of Mathematics, McMaster University, Hamilton, Canada (December 10)

Senior Lecturer, or Lecturer (Grade I) in Botany at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (December 12)

Senior Lecturer or Lecturer in Experimental Pharmacology—The Secretary, The University, Aberdeen (December 14)

Chair of Physics, Chair of Geology, Chair of Zoology, and Chair of Bacteriology in the University of Khartoum—The Registrar, University of Khartoum, c/o Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (December 15)

Empire Rheumatism Council Fellow (with medical or scientific qualifications), to prosecute research in the field of rheumatism—The General Secretary, Empire Rheumatism Council, Faraday House, 8–10 Charing Cross Road, London, W C 2 (December 15)

Assistant Lecturer or Lecturer in the Department of Zoology—The Registrar, The University, Liverpool (December 19)

Lecturer or Assistant Lecturer in Pharmaceutics at the University of Malaya (Singapore Division)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (January 15)

Imperial Chemical Industries Research Fellows in Chemistry, Physics, Metallurgy, Engineering, Geology, Agricultural Science and related subjects—The Registrar of the University of Wales, University Registry, Cathays Park, Cardiff (March 7)

Assistant Biochemist (Basic grade) (with an appropriate science degree, or Associate or Graduate Member of the Royal Institute of Chemistry) in the Department of Pathology—The Superintendent, Northampton General Hospital, Northampton

Assistant, Grade B, in Physics—The Clerk to the Governors, Woolwich Polytechnic, London, S E 18

Head of the Department of Aeronautical and Mechanical Design—The Registrar, Hatfield Technical College, Hatfield, Herts

Master to teach Mathematics, with a good share in sixth form work—The Headmaster, Bedford School, Bedford

Master to teach Science and Mathematics up to Middle School level—The Headmaster, King's School, Rochester, Kent

RESEARCH ASSISTANT TO WORK IN THE PHARMACOLOGY DEPARTMENT on inflammation and anti-inflammatory substances—The Dean, Guy's Hospital Medical School, London Bridge, London, S E 1

SENIOR ASSISTANT PHYSICIST (with some experience in medical physics) to act as deputy to the Principal Physicist and to take responsibility in radiation physics and isotope work—The House Governor, King's College Hospital, Denmark Hill, London, S E 5

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Council for the Preservation of Rural England Thirty-third Annual Report, 1958–1959 Pp 76+4 plates (London Council for the Preservation of Rural England, 1959) [810

Tobacco Manufacturers' Standing Committee Research Papers No 4 Cigarette Smoke Condensate—Preparation and Routine Laboratory Estimation By H R Bentley and J G Burgan Pp i+9 (London Tobacco Manufacturers' Standing Committee, 1959) [810

E M I News, Vol 1 No 1 (October 1959) (The Newspaper of the E M I Group of Companies) Pp 12 (Hayes, Middx Electric and Musical Industries, Ltd , 1959) [810

British Society for the Promotion of Vegetable Research Ninth Annual Report, 1958 (October 1957–September 1958) Pp viii+55 (Wellesbourne Warwick British Society for the Promotion of Vegetable Research, 1959) [810

British Museum (Natural History) The Neolithic Revolution By Sonia Cole Pp vi+60+18 plates (London British Museum (Natural History) 1959) 5*s* [810

Colonial Office The Colonial Territories, 1958–1959 Pp xxv+109 (Cmnd 780)(London H M Stationery Office, 1959) 10*s* 6*d* net [810

Post Office Report of the Advisory Committee on the Inland Telegraph Service, 1958 Pp iii+11 (London H M Stationery Office 1959) 1*s* net [810

Report of the Committee on the Rating of Charities and Kindred Bodies Pp iv+86 (Cmnd 831) (London H M Stationery Office, 1959) 5*s* net [810

Air Ministry Meteorological Office Tables of Temperature, Relative Humidity and Precipitation for the World Part 3 Europe and the Atlantic Ocean North of 35° N Pp x+159 (London H M Stationery Office, 1959) 14*s* net [810

British Scientific Instrument Research Association Research Report M 39 Adhesives Guide By Mrs Joyce Hurd Pp viii+138 (Chislehurst British Scientific Instrument Research Association, 1959) 20*s* [810

National Central Library 43rd Annual Report of the Executive Committee for the year ending 28 February 1959 Pp 20 (London National Central Library, 1959) [810

Scientific Council for Africa South of the Sahara Publication No 28 Radio Isotopes (Pretoria, 1957) Pp 230 Publication No 34 C S A Specialists' Meeting on Road Research, Lourenco Marques, 1959 Pp 48 (London Scientific Council for Africa South of the Sahara, 1959) [810

Fifth Report from the Select Committee on Estimates, Session 1958–59 United Kingdom Atomic Energy Authority (Production Group and Development and Engineering Group) Pp lxxxv (London H M Stationery Office, 1959) 5*s* net [1410

University of London University College Calendar, 1959–60 Pp lxvi+502 (London University College, 1959) [1410

Effects of Printing Types and Formats on the Comprehension of Scientific Journals By E C Poulton Pp ii+22 (Cambridge At the University Press, 1959) [1410

Department of Scientific and Industrial Research Building Research Station National Building Studies—Special Report No 29 Organization of Building Sites By R C Sansom (European Productivity Agency Project No 302/1) Pp x+186+20 plates (London H M Stationery Office, 1959) 21*s* net [1410

Department of Scientific and Industrial Research Problems of Progress in Industry—4 What They Read and Why—The Use of Technical Literature in the Electrical and Electronics Industries, By Nigel Calder Pp 24 (London H M Stationery Office 1959) 2*s* [1410

General Register Office The Registrar General's Quarterly Return for England and Wales—Births, Deaths and Marriages Infectious Diseases, Weather, Population Estimates, quarter ended 30th June 1959 (No 442, 2nd quarter, 1959) Pp 27 (London H M Stationery Office, 1959) 2*s* net [1410

Other Countries

Fisheries Research Board of Canada Bulletin No 120 Redfish Distribution in the North Atlantic By Wilfred Templeman Pp viii+173 (Ottawa Queen's Printer, 1959) 1 75 dollars [810

Epilepsia, Vol 1, No 1 (March 1959) Fourth Series (Journal of the International League Against Epilepsy) Pp iv+116 4 issues to the volume, approx 480 pages per volume Subscription price 57*s* , 8 dollars, or 30 D fl per volume (post free) (Amsterdam Elsevier Publishing Company, 1959) [810

Chemotherapy a Symposium held at the Central Drug Research Institute, Lucknow, November 2–4, 1958 Pp xi+176 (New Delhi Council of Scientific and Industrial Research, 1959) [810

Uganda Protectorate Annual Report of the Forest Department for the year ended 31st December, 1958 Pp viii+80+4 plates (Entebbe Government Printer, 1959) Shs 6 [810

Transactions of the American Philosophical Society New Series Vol 49, Part 5 The Anatomy of *Callimico goeldii* (Thomas) By W C Osman Hill Pp 116 (Philadelphia American Philosophical Society, 1959) 2 50 dollars [810

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Academy of Zoology, Agra Annals of Zoology Vol 2, No 1 *Heterosaccus indicus* sp Nov , a Rhizocephalan Parasite of the Crab, *Portunus pelagicus* (L) By H Boschma Pp 1–20 Vol 2, No 2 The Extracranial Carotid Rete and Carotid Fork in *Nycticebus coucang* By W E Adams Pp 21–28 Vol 2, No 3 The Second Maxilla in the Decapoda By P Heegaard Pp 39–46 Vol 2, No 4 A Revised Classification of the Psittaci Formes Based on the Carotid Artery Arrangement Patterns By Dr Fred H Glenny Pp 47–56 Vol 2, No 5 *Mizelleus indicus* N G , n sp (Subfamily Tetraonchinae), from the Gill Filaments of *Wallagonia attu* (Bloch) By Dr S L Jain Pp 57–64 Vol 2, No 6 The Anatomy of the Larva of *Enarmonia pseudonectis* Meyr (Eucosmidae Lepidoptera) By T P S Teotia and M D Pathak Pp 65–86 Vol 2, No 7 Chemical Seed Treatment of Maize for Control of the Wairworm *Melanotus cribulosus* (Leconte) By B K Srivastava Pp 87–94 Vol 2, No 8 The Indo-West Pacific Species of the Genus *Polyonyx* (Crustacea, Decapoda, Porcellanidae) By D S Johnson Pp 95–118 Vol 2, No 9 Interpretation of some Experiments Upon the Effects of Ionizing Irradiation on the Tissues of Amphibians By B M Allen Pp 119–126 Vol 2, No 10 The Golgi Apparatus Controversies, 1927–1957 By J Bronte Gatenby Pp 127–154 Vol 2, No 11 The Hyoid and Associated Structures in some Indian Reptiles By Dr Keshav Chandra Sondhi Pp 155–240 Vol 2, No 12 *Champse brevirostris* Werner 1933 is a *Crocodylus palustris kimbula* Deraniyagala 1936 By Otto v Wettstein Pp 241–242 Vol 3, No 1 The Embryonic Cuticle of *Locustana pardalina* (Walker) By R K Sharan Pp 1–8 Vol 3, No 2 The Academy of Zoology (General Information, Constitution, and List Members) Pp 9–36 Vol 3, No 3 The Effect of Host Species on the Oviposition of *Callosobruchus chinensis* Linn (Coleoptera, Bruchidae) By B K Srivastava and S K Bhatia Pp 37–42 (Agra The Academy of Zoology, 1958 and 1959) [810

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Indian Council of Agricultural Research Monograph No 27 Cultural Trials and Practices of Rice in India By M Subbiah Pillai Pp ii+167 (New Delhi Indian Council of Agricultural Research 1958) Rs 7 75 , 12*s* 6*d* [810

European Productivity Agency of the Organization for European Economic Co-operation The Small Family Farm a European Problem—Methods for Creating Economically Viable Units Pp 103 (Project No 199/2) (Paris European Productivity Agency of the Organization for European Economic Co-operation, 1959) 600 French francs 9*s* , 1 50 dollars , 6 Swiss francs [810

French Bibliographical Digest Biochemistry, No 27, Series II (April 1959) By Jean-Emile Courtois Pp 171 (New York Cultural Center of the French Embassy, 1959) [810

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Involution of the Ductus Arteriosus A Morphological and Experimental Study, with a Critical Review of the Literature By A Sciacca and M Condorelli Pp 52 (Basel and New York S Karger, 1959) 7 Swiss Francs [810

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International Atomic Energy Agency, Vienna International Directory of Radioisotopes Vol 1 Unprocessed and Processed Radioisotope Preparations and Special Radiation Sources Pp ix+264 (Vienna International Atomic Energy Agency, Kärtner Ring, 1959) [810

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ORGANIZATION OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH IN BRITAIN

IN the election manifesto of the Conservative Party released on September 11, it was stated that, as the first of five measures to promote technological advance in Britain and to translate this into productive capacity with a high and rising rate of investment, one Cabinet Minister would be given the task of promoting scientific and technological development "While it would be wrong to concentrate all Government scientific work into a single Ministry, this Minister for Science will have responsibility for the Department of Scientific and Industrial Research, the Medical and Agricultural Research Councils, the Nature Conservancy, the atomic energy programme, and the United Kingdom contribution to space research" The manifesto added that the development of nuclear energy for peaceful purposes would be pressed ahead, a conference called for those concerned in industry and education to forward the spread and understanding of automation, while besides encouraging new inventions and the development of new techniques, further changes would be made from time to time in the functions of Ministers as might be necessary to meet modern needs

This emphasis on the importance of science in the national welfare and the need to adapt administration to ensure that due account is taken of scientific and technological advance, was followed on September 17 by a special statement from the Labour Party entitled "A New Deal for Science" This statement proposed the appointment as "Minister of Science" of a senior Minister with general responsibility for scientific affairs and the authority to perfect and carry out by and through the various Ministries concerned a carefully planned programme to use modern science to the full This programme would include a further expansion of scientific and technological education, more scientific training in the schools, and consequently more science teachers, a substantial increase in the number of research and development contracts and Government grants to individual firms for approved long-term research projects , and the establishment under the Minister of a scientific and technical planning board to advise on the direction of industrial research and development, on the awards of research contracts and on the grants to individual firms

Both major political parties of Britain have thus committed themselves to some modification of the organization of research and development in the country, and of the means by which scientific and technical advice is presented at the highest level Neither statement gave sufficient information to allow a sound judgment as to which is the more promising proposal, but now that Mr Macmillan has been returned to power he has lost no time in making the promised appointment The Cabinet changes announced on October 14 included the appointment of Lord Hailsham as Lord Privy Seal with the general duty of promoting scientific and technological advance in consultation with the departmental Ministers No Ministry of Science is to be created , indeed, it is pertinent to observe that Lord Hailsham gave last April a reasoned argument against the practicability of any such appointment, and it is clear that Ministers will retain executive responsibility for scientific matters within their own departments and that no attempt will be made to limit the freedom and initiative of universities or industry in determining the content of scientific education or the direction of research

Lord Hailsham, who relinquishes the chairmanship of the Conservative Party, takes with him, from the Lord Presidency of the Council, ministerial responsibility for the work of the Department of Scientific and Industrial Research, the Medical Research Council, the Agricultural Research Council and the Nature Conservancy , this constitutes a definite break with the structure built up in the past forty years and more He will also assume responsibility for the work of the Atomic Energy Authority, the Atomic Energy Office, the Overseas Research Council and supervision of the British contribution to space research At a Press conference on October 14, Lord Hailsham indicated that his task would be to do some fundamental thinking on the relations between Government and science, and he stressed his anxiety to do nothing to interfere with the independence of the Government-financed scientific bodies Essentially he confirmed the views he expressed last April to the Institution of Chemical Engineers, and indicated that the appointment was only likely to show results after a long period and that its terms were not such as could easily be put down on paper

It is thus unlikely that Lord Hailsham's appointment contributes anything material at the moment to the formal organization of the scientific effort of Great Britain, either in research and development or in other fields Lord Hailsham's addresses to the Institution of Chemical Engineers and the Institute of Physics last year showed how well aware he is of the dependence of our scientific and technical effort not merely on the resources allocated for such work, but also on education, and the interlocking of problems of application with those of defence as well as of industry Equally he recognizes that if educational and scientific institutions are to function efficiently, they must retain complete integrity, and accordingly a high degree of independence His conception of a scientific policy—and presumably in this he includes technological policy—is of a partnership in which Government, teaching institutions, research institutions and industry all play important and interrelated parts It could well be that Lord Hailsham was selected for his new office because he has publicly stressed the need for a more intelligent understanding of the forces at work and has indicated that he was already thinking deeply about the relations between Government and science

There can be little doubt that Lord Hailsham intends to consider whether the new arrangements are adequate, and whether they can be improved; but there seems little reason to fear that new administrative arrangements will be created without due forethought and consultation, or new policies concerted and applied unimaginatively or without due regard to the essential conditions for scientific work It may be expected that Lord Hailsham's inquiries and thinking will lead to the elimination of some of the duplication of effort that can be found, though it is improbable that he will fail to recognize that there are occasions when such duplication is an advantage and an asset rather than waste What is important is that Lord Hailsham appears to be bringing to his task the breadth of vision, the imagination and something of the understanding of the mind of the scientist that are essential for success.

What is more important, perhaps, is that Lord Hailsham himself recognizes that the task of Minister of Science or for Science is inherently impossible for any one man to discharge, and he is likely to look rather for the administrative arrangements which may best permit the Government as a whole to take full account of the scientific and technical factors involved in its decisions on policy and to ensure an adequate and balanced apportionment of our resources in man-power, in finance and in materials for scientific and technical work generally If also he examines the question whether, as has been alleged, the authority of scientists in the key Departments of State is really being dangerously eroded, he will have done as much as can fairly be expected of any one man

The statement, "The First Minister for Science", which Lord Hailsham has since issued (see p 1263) of this issue of *Nature*) confirms all this He emphasizes the need for other Ministers in the Government to be scientifically minded if his work is not to be incomplete, and he stresses again that his appointment should impel scientists themselves to take a share in thought about scientific policy Such a policy, he reiterates, cannot be the product of Government thinking alone

Several specific points in this statement should also be noted Lord Hailsham believes that Government science, and perhaps all British science, is at present too parochially minded, too departmentalized and lacking in broad vision He believes also that the Advisory Council on Scientific Policy holds the key to the situation, and announces his intention of relying more upon this Advisory Council for general advice on questions of scientific policy With this welcome indication that the Advisory Council's authority is to be restored comes the admission at last that the office of the Lord President of the Council has been under-staffed, and the warm welcome which scientists generally will extend to the whole tenure of Lord Hailsham's statement will be accompanied by greater confidence in that he is now likely to enjoy the services of a larger and more flexible office staff Lord Hailsham's efforts to tackle such questions as the general balance of scientific effort, to forge closer ties between Government research stations and institutes and the universities, and to foster alike applied research and increased benefactions for universities and colleges, will carry the greater conviction in this context, and it should also assist to enlist the support of scientists and technologists generally, for which he pleads

Above all, it is important that Lord Hailsham's appointment should be regarded as a challenge to scientists and technologists generally to think deeply about the issues displayed in this statement, many of which were set forth earlier by Lord Hailsham and Sir Hugh Beaver in their addresses to the Institution of Chemical Engineers It should not be forgotten that, however admirably an administrative structure may be devised and established, its effectiveness will always largely depend on the men who use it Apart, too, from the perennial temptation to look for rapid political returns rather than the long-term gains which a sound scientific policy would offer, the penetration of science into the more backward industries and into some Departments of State is a matter both of education and of personal influence Personalities again may play a vital part, especially when it is a matter of securing co-operation

It is accordingly worth while to look carefully at the way previous arrangements have functioned before deciding on further changes Valuable clues may well be found as to the essential conditions, and even in the context of the new responsibilities which Mr Macmillan has entrusted to the office of Lord Privy Seal, Lord Hailsham will not find it easy to give better services to science than have been rendered by some of his predecessors as Lord President of the Council, notably Lord Balfour and Lord Waverley The late Sir Walter Morley Fletcher has written of Lord Balfour's deep interest in the work of the Medical Research Council, the chairmanship of which he retained when he became Lord President in spite of the anomaly Lord Balfour was no less interested, however, in the work of the Department of Scientific and Industrial Research, and sought strenuously to increase effective contact between scientists themselves and also between them and the administrative departments, promoting for this purpose the establishment of the Committee of Civil Research, the counterpart of the Committee of Imperial Defence

Besides the testimony of members of these Councils and Committees to the encouragement and inspiration derived from the experience of encountering a statesman who possessed both the power to help research and the imagination to understand its value to the State, there is on record the further services to science which Lord Balfour rendered at the Imperial Conference of 1926 Balfour said at the time that he regarded the work of the Research Sub-Committee of the latter Conference, over which he presided, as only second in importance to that of the Committee on Inter-Imperial Relations, and in its proposals for co-ordinating research he sought to forge new cultural links between all parts of the Commonwealth, through the departments and individuals engaged in scientific work in every field The recently formed Overseas Research Council owes something to the foundations thus laid, and it might well be worth re-examining the circumstances which have held back for a generation such a promising start

If there is thus on record how much can be achieved by a Minister with vision and imaginative understanding of the needs of the scientist, there is also testimony to the value of a Cabinet Minister himself trained as a scientist Such tribute has been paid in regard to both Sir Stafford Cripps and Lord Waverley, notably in regard to the latter by Earl Attlee and also by Lord Winster, who during the Second World War had been given responsibility as a Cabinet Minister for the promotion of science and was for a time a member of the Cabinet's scientific advisory committee (out of which the Advisory Council for Scientific Policy later developed) when Lord Waverley was Lord President of the Council Lord Hailsham himself has stressed the authority which Lord Waverley could derive in scientific matters from being able to speak as a science graduate Lord Bridges has testified to the outstanding quality of Lord Waverley's work as Lord President of the Council, not only to his capacity for understanding and sound judgment, but also to the way in which he worked so far as possible through departmental staffs without building up any large organization of his own, and also to the importance of the complete confidence which existed between the Lord President and the Prime Minister

Lord Bridges, in his Royal Society memoir, referred particularly to Lord Waverley's services to science both while he was Lord President during 1940–43 and afterwards, particularly in what might be called the scientific administration of the development of nuclear energy It is too early yet to expect the critical biography of Lord Waverley which might illuminate these arrangements more fully, but it is important that they should be examined as fully as possible in the light they could throw on the kind of arrangements which are desirable to-day They suggest, for example, that any constructive thinking should include a careful appraisal of the functioning of both the Advisory Council for Scientific Policy and the Research Defence Policy Committee

Even this cursory review indicates the critical importance of personal factors, and there is a further reason for looking closely into this aspect The late Sir Henry Tizard, who has claims to be considered as a military scientific genius, was very successful in his joint chairmanship of the Advisory Council for Scientific Policy and the Research Defence Policy Committee during 1946–52 Nevertheless, in spite of the conspicuous services he had rendered even before the Second World War in developing defence research policy and later in encouraging the development of operational research, in 1942 he suddenly resigned from most of his official appointments to become president of Magdalen College, Oxford Sir Henry was one of the easiest of colleagues, so any administrative structure which led to such a decision is *ipso facto* suspect Incidentally, in their Romanes and Haldane Memorial Lectures, respectively, both Lord Waverley and Sir Henry Tizard have recorded considered opinions and constructive proposals for providing the Government with more authoritative guidance in technical matters

It may be hoped that Lord Birkenhead's official biography of Lord Cherwell will in due course throw some light on these matters Sir George Thomson in his Royal Society memoir refers briefly to the existence of conflicts of opinion between Cherwell and Tizard which were well known in the scientific world, but no light is thrown on this by Sir Roy Harrod's more recent personal memoir, "The Prof ". He does, however, indicate another aspect of some interest in considering the functions of a Minister of Science It is the personal relations between Lord Cherwell and Sir Winston Churchill, first as First Lord of the Admiralty and later as Prime Minister, rather than Lord Cherwell's own subsequent position in the Cabinet as Paymaster-General that are of primary interest Lord Cherwell was able to render his great contribution to the national war effort because of the extent to which he possessed Mr Churchill's confidence and understanding

What Sir Roy Harrod writes of this relationship will bear pondering Where such confidence and understanding can be established, from whatever beginning, the outcome may well be as effective for the promotion of science and technology as when the Cabinet Minister concerned has himself been trained in science It might possibly be a waste of scarce and highly trained man-power, even if it were possible, to provide every Cabinet Minister carrying departmental responsibilities involving highly technical and scientific matters or research with a scientific adviser of Cherwell's quality for his personal assistant The results in any event would depend alike on the quality of that adviser's mind and on the personality of the Minister, as well as on the intimacy of the relations between him and his adviser , but it should be clear enough that it is not sufficient for scientific and technical advice to be presented at one point alone The effective formulation of policy where science and technology are concerned will come when such factors are accurately assessed, not by one Minister only, but all the Ministers concerned

There could well be found here the reason why the single-handed efforts of Lord Balfour a generation ago and the advocacy of such men as Lord Samuel have hitherto failed of full fruition For that reason alone the functioning of the advisory committee compared with that of the personal assistant or adviser requires further examination Moreover, in Sir Roy Harrod's memoir of Lord Cherwell the emphasis is on the contribution which Lord Cherwell and his statistical section made to quantitative thinking about the conduct of the War, and Sir George Thomson's memoir appears to confirm that this was the most important characteristic of Lord Cherwell's contribution This again suggests that there is something to be learned from the functioning of this section and the work of the Central Statistical Office established in 1941.

There can be no doubt as to the immensity of the task which Lord Hailsham has undertaken, and the diversity of problems he will need to consider. Now that he has divested himself of his party political responsibilities as chairman of the Conservative party, he appears to be as good a choice as could have been made. His experience as Lord President of the Council has already given him a close insight into some of the problems involved and his speeches have shown both that he is thinking deeply about the real issues and that he is averse to hasty and unilateral decisions.

If it should be reiterated that Lord Hailsham's appointment represents no essentially new departure, similar positions having been occupied by Lord Balfour more than thirty years ago and by Lord Winster and possibly Lord Waverley in the Second World War, the scale and range of problems now confronting him cannot be compared with those presented to any predecessor in peace-time. He will doubtless examine the functioning of the Advisory Council for Scientific Policy and its interrelations with the Defence Research Policy Committee, as well as the specific problems and relations of the several research councils and organizations for which he is specifically responsible. There is the question of departmental research as against centralized research, for example, under the Council for Scientific and Industrial Research. There is a whole range of problems presented by the industrial research associations and the stimulation of research and its exploitation in industry. There is the matter of the balance of our research effort generally and the place of the universities and the independent research institutions and the resources at their disposal and the way in which Government policy can best strengthen such resources without infringing academic or professional autonomy. There are problems which will lead Lord Hailsham into the educational field, as when he considers our resources in scientific and technical man-power and their expansion, as well as their most effective deployment.

Nor are all these problems sharply separated. The support, for example, which the Department of Industrial and Scientific Research already gives to the universities, both by way of grants to individuals for postgraduate study and to university departments in support of specific research projects, already takes it within the orbit of the University Grants Committee, and this holds in varying degree for the other research councils also. It is arguable that nowhere below the level of the Prime Minister himself can all the responsibilities involved rest in one man, if indeed the task is not too immense for any person to discharge it alone. There, of course, we touch the question of Cabinet responsibility, but without entering on any such discussion it might be observed that the Cherwell–Churchill relation seems at least to support the view that a Minister who carried general responsibility for scientific (and presumably also technological) matters might be able to give the Cabinet sufficient detailed advice to clarify and facilitate decisions either in the Cabinet or by the Prime Minister himself. Lord Hailsham is obviously approaching these questions without preconceived ideas as to whether changes are required in our present arrangements, and if so, what changes for the better are possible, and he has at his disposal much valuable evidence not merely from Lord Waverley, Lord Bridges and Sir Henry Tizard, but also from others like Lord Hankey, Lord Ismay and Sir Henry Dale. Whatever the administrative structure may be, there is one essential condition if it is to function smoothly: effective measures must be taken to eliminate or bridge the gap between what Sir Charles Snow has described so vividly as the two cultures. The effective use of science and technology for the public welfare and in the affairs of State will not be ensured by establishing a Ministry of Science or appointing a special Minister. It will be secured in the measure, and only in that measure, in which Ministers and administrators, the Departments of State, the public corporations, industry and the public generally are aware of the conditions and nature of scientific work, understand in some degree what science is doing and are prepared to provide the necessary support.

THE PRINCIPLES AND PRACTICE OF CROP PROTECTION

The Scientific Principles of Crop Protection

By Hubert Martin. Fourth edition. Pp. viii+359. (London: Edward Arnold (Publishers), Ltd., 1959.) 65*s.* net.

Advances in Pest Control Research

Vol. 2. Edited by R. L. Metcalfe. Pp. vii+426. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1958.) 94*s.*

Recognition of Diseases and Pests of Farm Crops

By Ernst Gram, Prosper Bovien and Chr. Stapel. (Danish Agricultural Information and Advisory Aids Service.) Pp. 128+112 colour plates. (Cambridge: W. Heffer and Sons, Ltd., 1958.) 35*s.* net.

The Control of Pests and Diseases in Agricultural and Horticultural Crops

By G. L. Hey and K. Marshall. (Agricultural and Horticultural Students Series.) Pp. 172. (London: Vinton and Co., Ltd., 1958.) 12*s.* 6*d.* net.

TO say that, nuclear wars apart, the greatest problem of the future will be to feed the rapidly increasing human population is none the less true for being trite. Happily there is no need to think it is insoluble. Average crop yields are so low that the scope for improvement is enormous, and starvation can be avoided for a long time simply by improving the health of crops. Over much of the world most crops are left to fend for themselves, unaided in their struggle with pests and diseases. What annual toll these predators take cannot be estimated at all accurately, but there is little doubt that human beings will have at least twice as much to eat when they stop sharing their crops with pests and diseases.

The four books listed above differ greatly in content and immediate purpose, but all have the same ultimate aim of increasing yields by protecting plants against their pests and diseases. They make it clear that many of the losses now suffered are legitimately described as avoidable, in the sense that they could be avoided by applying existing knowledge more widely, but it is also clear that much new knowledge will be needed before all losses come into this category Between them the books also show how complex and varied are the problems entailed in improving the health of crops First, there are the research problems, diagnosis of the cause, the biological study of the pest or pathogen to find where it comes from, how it spreads and whether there is a stage in its life history at which it is especially open to attack, and this to be followed by tests of pesticides, of variations in cultural practices or of seemingly resistant varieties Secondly, when research has produced a control method, there still remains what is often the more difficult task of getting it established in practice, and even with this achieved the position must be closely watched to ensure that the method remains effective and has no undesirable side effects.

"The Scientific Principles of Crop Protection" is one of the few books that attempt to cover the whole subject, and a new edition was long over-due, for most of the insecticides currently used have been discovered since the third edition was published in 1940 The title has been changed to the extent that 'plant protection' has become 'crop protection', but the presentation and approach are as before The new edition might have been even more welcome had the changes been greater, for it is now more difficult than twenty years ago to contain the subject in a single volume and some parts get scant attention considering their recent growth Whether the parts briefly mentioned should have been omitted in favour of more detail on those in which the author is most authoritative, however, is a moot point, for in these days of increasingly narrow specialization it is certainly refreshing to find someone willing to look at the subject broadly, even though the looks in some directions may be only glances

Review journals are necessarily complements to standard texts They are better able to keep up with advances in the subject and they provide opportunities for specialists to present detail inappropriate in a general book The eight articles in volume 2 of "Advances in Pest Control Research" cover a wide range of subjects and some authors have undoubtedly made full use of the opportunity to be detailed Here the contents can only be indicated by summarizing the titles and naming the authors fluid kinetics of sprays (R P Fraser, 106 pp), toxicity of fungicides (S E A McCallan and L P Miller, 28 pp), seed and soil treatments with insecticides (H T Reynolds, 48 pp), the use of isotopes to measure spray residues (C T Redeman and R W Meikle, 24 pp), wool digestion and moth proofing (D F Waterhouse, 56 pp), the relation of chemical structure to herbicide activity (R L Wain, 44 pp), chemical structure and activity of DDT analogues (R Riemschneider, 44 pp), the spread of resistance to insecticides in pests (A W A Brown, 64 pp) It is to the credit of the authors that most have accepted the editor's invitation to evaluate their subjects critically and have not simply summarized published work

The other two books are for the grower of crops rather than the research worker "Recognition of Diseases and Pests of Farm Crops" is a most welcome and most unusual book The text consists simply of captions to the 112 magnificent colour plates containing more than 700 beautiful water-colour paintings by I Frederiksen and E Olsen The sole purpose is to aid diagnosis, which the book will do permanently and everywhere, and methods for controlling the pests and diseases so accurately portrayed are deliberately omitted because they often change and may differ in different countries The book by G. L Hey and K Marshall complements the work of art from Denmark and contrasts strikingly with it It is most valuable for its succinct recommendations for controlling specific pests and diseases, is least satisfactory for diagnosis, and its pictures are neither beautiful nor very helpful With both books, the farmer or gardener is well equipped to avoid much loss, and it is no mean testimonial to the achievements of plant pathologists that growers now have reliable methods to control so many pests and diseases

F C Bawden

FREE RADICALS

Free Radicals as Studied by Electron Spin Resonance

By Dr D J E Ingram Pp ix+274 (London Butterworths Scientific Publications, New York Academic Press, Inc, 1958) 50*s* , 9 50 dollars

Free Radicals

An Introduction By A F. Trotman-Dickenson (Methuen's Monographs on Chemical Subjects) Pp viii+142 (London Methuen and Co, Ltd , New York John Wiley and Sons, Inc , 1959) 12*s* 6*d* net

MOST free atoms are associated with one or more unpaired electrons, and the formation of compounds generally involves the complete pairing of such electrons in molecular orbitals Nevertheless, many molecules, of widely varying degrees of structural complexity, have a single unpaired electron These bodies, known as monoradicals, comprise the most important group of free radicals, and it is with them that the greater part of both of these books is concerned

The unpaired electron confers two important properties on the monoradical In the first place the electron spin is associated with a magnetic moment, which may align itself in one of two ways with respect to an applied magnetic field Transitions between the energy-levels corresponding with these two alignments can be made to fall conveniently in the microwave region, giving the phenomenon known as electron spin resonance The transition will be associated with hyperfine structure resulting from the interaction of the electron spin with the various nuclear spins, if any, in the radical This hyperfine structure may then be used to 'locate' the electron within the molecule, and hence to obtain information about the orbital, and about the structure of the molecule In the second place, the presence of an unpaired spin within a molecule makes it more reactive, and free radicals often play important parts in chemical reactions, since their reactions can provide convenient paths by which the final products may be produced most easily Dr Ingram's book is concerned with the first of these aspects of free radical behaviour, and Dr Trotman-Dickenson's with the second, in particular with the elementary reactions of free radicals, while avoiding chain reactions and oxidation processes

The overlap between the books is very small, and it is a pity that they have effectively the same title, differing only in subtitle In both cases the contents are excellent, and may be recommended to all workers in the field of free radicals

Dr. Ingram's work falls into two main sections, the first being concerned with the techniques of electron resonance, and with those parts of the theoretical background necessary for the interpretation of the spectra of free radicals. The 'experimental' part will be a most valuable guide to those contemplating work in this field, to many of whom microwave methods will be unfamiliar. The various types of spectrometer are clearly explained, and their relative merits discussed; the appendix, dealing with sources of equipment, is a worthwhile addition. A pleasing account of the sources of hyperfine structure follows. The rest of the book is a sectionalized review, with useful explanations, of work up to the present. There are chapters on stable free radicals (mostly fairly elaborate organic molecules or ions), on 'trapped' radicals produced by irradiation of solids or materials in glasses, and on the radicals formed in the course of polymerization and of pyrolysis (of solids). All are interesting, and suggest future applications. Dr. Ingram's field defines itself well without the rather odd definition of a free radical which he gives (p. 2), in which reference is made to 'normal chemical bonding'; all free radicals are held together by normal chemical bonding.

The book by Trotman-Dickenson is, in effect, an extended and intelligently written review covering a field of chemistry with a much longer history. It is of great value in so far as it ignores the artificial boundaries which appear to have arisen in chemistry, and because of its systematized account and assessment of a very large amount of material. It is not the author's fault if the available matter for some of the sections is inconclusive. The book will prove useful to those connected in any way with this amorphous field.

Both books attempt short treatments of 'biradicals', from very different points of view. This topic holds much for the future. T. M. SUGDEN

THE IMPORTANCE OF NEW DETECTORS

Čerenkov Radiation and Its Applications

By Dr. J. V. Jelley. Pp. x+304. (London and New York: Pergamon Press, 1958.) 65s. net.

IT is seldom that the first book to appear on any topic is so thorough as this work by Dr. Jelley. The treatment of the largely new subject of Čerenkov radiation is very complete in its scope and the many workers in the field, whether they are engaged in fundamental studies of this form of radiation or in some relatively straightforward application of a tool based on the phenomenon, owe a debt of gratitude to the author for this comprehensive study. Those who heard the evening discourse by Academician Tamm at Geneva in 1958 were given a clear picture of the rather intriguing history of the subject and the relatively sudden introduction of practical detectors, based on the Čerenkov effect, seemed the more surprising.

Jelley has gleaned his material from many rather scattered sources and presented it here in a well-integrated form. The rather extensive theory is well supported by his clear expositions of the experimental work in the field and in this he shows the skill of one who has personally made considerable contributions to the subject. The author makes it obvious that the subject is likely to produce more surprises in the future and those interested will find much to stimulate their thought in this volume. Many fruitful researches can be expected in this field and Jelley himself indicates some of these. Modern physics perhaps owes its rapid progress more to the introduction of novel detectors than to any other successes. We need but mention the Geiger and proportional counters, the Wilson cloud-chamber, the nuclear emulsion-plate, the scintillation counter, the Čerenkov detector and the bubble chamber to realize the fundamental nature of the contribution that stems from the study and perfection of these devices. Moreover, their value extends to many fields beyond that of pure physics.

The volume can be very highly commended as a most readable, careful and thoroughly up-to-date account of the subject.

THE VERY COLD WORLD

Experimental Techniques in Low-Temperature Physics

By Guy Kendall White. (Monographs on the Physics and Chemistry of Materials.) Pp. viii+328. (Oxford: Clarendon Press; London: Oxford University Press, 1959.) 45s. net.

ABOUT a quarter of a century ago, all low-temperature physicists (and there were not many of them) knew each other, and picked each others' brains fairly regularly, so that the dissemination of cryogenic techniques was rapid and satisfactory. To-day, however, when every well-equipped physics laboratory has or should have its cryogenic facility, the older method of communication is no longer adequate. Many physicists all over the world now want to be able to handle cryogenic liquids safely and efficiently; hence the timely appearance of this useful book on cryogenics, the first for nearly twenty years and the first in the English language.

A wholly satisfactory book on techniques is a difficult thing to achieve, probably because a technique is part of a craft and the communication of a craft is not easily done by the printed word. In spite of this difficulty, here is a book which will be of very great assistance to new hands at the low-temperature game, and of not inconsiderable value to the old hands as well. An especially good feature is the 'feel' it gives for cryogenic physics, which will be appreciated by its practitioners.

There are faults, of course. The book strays too frequently into theory. No one is seriously going to read this book to find out how electron spins align themselves in an external magnetic field, or to study the formal derivation of the absolute thermodynamic scale of temperatures. But there are excellent chapters on heat exchangers and their calculation, on mechanical thermal contact, and on thermometry. The important methods of cryostat temperature control are well described, although it would have been valuable to have included some of the electronic circuit diagrams with magnitudes of quantities to give any desired sensitivity of control.

The chapter on vacuum techniques, soldering and sealing is good so far as it goes, but there is no mention of how to make a soft soldered joint that (*a*) will be mechanically strong, (*b*) will never leak, and (*c*) can be non-destructively unsoldered. Further, there is no mention of leak-hunting, that grimmest of pursuits, or of real or virtual leaks, or indeed of whether or not the author personally believes in such things as low-temperature leaks The diagrams of actual apparatus are often too schematic to be of great use, for example, the transfer tube and valve on pages 53 and 55, of the design of both of which I disapprove There is a mention of the use of spontaneous oscillations as a means of liquid level indication, but no description of this odd phenomenon nor any warning of its often annoying and occasionally horrifying effects

All of those are, however, minor criticisms The book contains a mass of useful cryogenic information Generally it gives highly commendable critical comparisons of various experimental methods, such as those used in calorimetry, and for the first time collects really valuable critical data on emissivities and on total thermal conduction and expansion coefficients between room temperature and 1° K

J F ALLEN

A BIOCHEMIST'S GUIDE TO THE NERVOUS SYSTEM

Biochemistry and the Central Nervous System

By Prof Henry McIlwain Second edition Pp vii+288 (London J and A Churchill, Ltd, 1959) 45s

IT is a considerable achievement for Prof McIlwain to have produced a second edition of his book (already translated into Spanish and Japanese) in such a relatively short time The need for a new edition is some indication of the rapid increase in our knowledge of the biochemistry of the nervous system to which the author and his colleagues at the Maudsley Hospital have made valuable contributions

The layout of this book follows the previous pattern though there have been extensive revisions and additions There is, for example, a new chapter, which is very much to the point, on the relation of the brain to the body as a whole, and the section on brain lipids has been considerably modified in the light of recent observations Knowledge of the metabolism and functions of proteins in the brain is still somewhat limited, but until Table 6, on the chemical nature and diversity of brain proteins, can be extended it is likely that progress on this particular aspect will be slow I was again impressed by details given about the rates of chemical reactions in brain and their relation to the speed of cerebral processes, information which is becoming more valuable as it becomes more extensive

Much useful information is summarized in diagrams and tables (Fig 34 and Table 28 are instances of this) It is perhaps significant that one of the column headings in Tables 8 and 9 has been changed from "acid-labile phosphate of adenosine triphosphate" to "acid-labile phosphate of purine nucleotides" in the second edition, thus indicating that the free nucleotide content of cerebral tissues is more complex than had previously been indicated

The chapter on chemical factors in nervous transmission is an extremely able résumé of a mass of information, and some indication of the speed at which this subject is developing can be deduced from the fact that references to the possible role of γ-aminobutyric acid as a pharmacologically active agent are all dated 1955 or later Biochemical aspects of the action of depressants and excitants receive their due, and in view of the current multiplication of drugs this summary is of some considerable value Perhaps the one surprising omission in the book is an appraisal of the extensive work of Geiger and his colleagues on the metabolism of the isolated, perfused brain *in situ*

Elsewhere the author of this volume has remarked, "Until the central problems of neurochemistry have been successfully tackled and we see more clearly how the nervous system utilizes its large energy supply in nervous transmission and in maintaining the system in a state of readiness to react, and how the brain is moulded to an animal's experience, chemical aspects of most of the neurological sciences—and above all, material approaches to nervous, mental and emotional diseases—remain as empirical as was organic chemistry before the advent of structural formulæ" If this book promotes further studies on this intriguing but complex subject then we shall all have been well served Indeed, it can be recommended to anyone who wishes to learn something of the biochemical processes underlying nervous activity and the relevance of these processes to a study of mental diseases A comprehensive bibliography at the end of each chapter and, for a book of its size, a monumental index, make it an extremely useful handbook in a field where suitable handmaidens are hard to come by

G B ANSELL

FAUNA OF NETHERLANDS NEW GUINEA

The Animal World of Netherlands New Guinea

By Dr L D Brongersma Pp 71 (Groningen J B Wolters, 1958) n p

THE island of New Guinea remains little known to the majority even to-day, and its fauna has received little attention through television or in popular published work It is one of the remaining major areas in which new zoological discoveries are likely to be made and is a region as yet little touched by commercial development Its animals, despite their affinities with Australia, are unique and much work remains to be done before they are fully surveyed Geographically, the island and its outliers form the most western extension of the Sahul shelf, and the study of the fauna is vital to the zoogeography of Australasia For these reasons the publication of a semi-popular account of the fauna of New Guinea is both timely and welcome Dr L D Brongersma has produced an interesting and factual book, based on his radio talks on the subject Written for the layman, the book is concerned with the novel and unusual, but also contains much of interest to the specialist Notable peculiarities among mammals, birds reptiles, amphibians, fish and crustaceans are described, with notes on their habits, ecology, economic value and sometimes history The text is enlivened by field observations, line drawings and photographs The author stresses the need for nature conservation in New Guinea, with emphasis on the dangers of uncontrolled commercial development and ill-considered introduction A short chapter and a map of the Sunda and Sahul shelves give a background to the origin of the fauna, and the book concludes with a useful account of the zoological exploration of New Guinea The author, whose aim was to encourage interest in the fauna of New Guinea and its conservation, has written a thoroughly readable account of the novelties and notable animals of the island

J E HILL

Mineralogy and Geology of Radioactive Raw Materials

By Prof E Wm Heinrich Pp xiv+654 (London McGraw-Hill Publishing Company, Ltd , 1958) 112*s* 6*d*

IN recent years more geologists have been engaged in explorations for radioactive ores than in any other hard-rock phase of the mineral industry, and since the lifting of security restrictions many thousands of research papers on radiogeology have seen the light of day Prof Heinrich has set himself the task of evaluating and summarizing this vast literature, and the result of his labours is the most outstanding monograph on uranium and thorium mineralization that has yet appeared in any language The work begins with approximately 150 pages on systematic mineralogy, continues for 400 pages with a lucid and descriptive classification of the world's radioactive ore deposits, and ends with 100 pages of bibliography (1,000 items) and comprehensive indexes Not all his views are uncontroversial for example, the designation of the Witwatersrand and Blind River ore-fields as respectively mesothermal and hypothermal epigenetic mineralizations will find little acceptance in the placerist schools of South Africa and Germany But all geologists concerned with the radioactive elements, academic workers and prospectors alike, will find interest and inspiration in these pages Nearly all the 200 text-figures are new to text-book literature Some minor errors in place-names, in the failure to recognize synonymous localities (for example, Kasolo and Shinkolobwe) and in the consistent mis-spelling of the mineral names thucholite and parsonsite should be corrected in the second edition, which will doubtless be required as soon as the present glut of uranium is taken up by industry and geologists are once again called on to find new ore fields

C F DAVIDSON

Substitution at Elements other than Carbon

By C K Ingold (The Fifth Weizmann Memorial Lecture Series, May 1958) Pp viii+52 (Jerusalem The Weizmann Science Press of Israel, 1959 Distributed by the Weizmann Institute of Science, Rehovot) n p

THIS little book is a record of four lectures and is divided into two chapters The first of these discusses substitution in some co-ordination compounds, principally derivatives of cobalt (III) Attention is directed to the stereochemical course of substitution by the unimolecular and bimolecular mechanisms, and to the particular problems associated with group replacements in molecules of octahedral symmetry An appendix is also provided to support further the theory of a direct S_N2 mechanism

The second chapter is concerned with nitration and nitrosation at nitrogen and oxygen atoms There is much more evidence available in this field and the author has surveyed it lucidly and succinctly The various reagents and mechanistic ambiguities are well set out and some ingenious experiments which exclude many of these alternatives are carefully detailed

The work is clearly printed and the diagrams are well produced There is no index, but a generous bibliography at the end of each chapter which is of greater value in a book of this length The only error I noticed is the omission of the minus sign from NO_3^- in the last relevant equation on page 32

This book is valuable both as a summary of the present position in this rather neglected study and for the outlining "of a mechanistic pattern", to quote the author's own words In his preface Sir Christopher suggests that prospects are extensive, and I feel that the analysis given in this work signposts the way well into a largely uncharted region

R I REED

Contact Catalysis

By Dr R H Griffith and J D F Marsh Pp x+300 (London Oxford University Press, 1957) 50*s* net

IN these days of many-volume treatises on catalysis, the smaller book also has its place , and the publication of a third edition of Dr Griffith's well-known text-book on contact catalysis, now written with the collaboration of J D F Marsh, is both timely and welcome It continues to give a condensed and well-planned survey of many of the more important classes of reactions involved in heterogeneous catalysis, together with an adequate treatment of the underlying theory

In order to accommodate, in a condensed form, the large amount of additional material which has resulted from the intense study which this subject is receiving, three new chapters have been added These deal, respectively, with modern practice in the preparation and empirical evaluation of stable catalysts having a high specific surface, with the part played by electronic factors in determining the catalytic activity of metals, and with a number of reactions involving hydrocarbons There has also been considerable rearrangement of the older sections of the book, and much of the descriptive matter on the promotion of catalysts by small amounts of subsidiary components and on the poisoning of catalysts has been revised and brought up to date This applies also to the chapter on the part played by geometrical factors, and especially by interatomic distances, in accommodating without undue strain the reactive portions of catalysable substrates The volume ends with a critical survey of modern progress in catalysis, with some forecasting of possible future developments This book continues to form an excellent summary of modern trends in catalysis

E B MAXTED

Practical Animal Ecology

By W H Dowdeswell Pp 316+16 plates (London Methuen and Co , Ltd , 1959) 32*s* 6*d* net

IN many British schools and universities lip-service is paid to the importance of field studies in zoology, whereas the actual practical effort is often limited to a few days at a field study centre or attendance at a single Easter-course in marine biology

Here, almost for the first time, is a book which will really assist teachers and lecturers to introduce their students to modern animal ecology The book lives up to its title A wide range of methods and techniques is described which are applicable to the study of terrestrial, freshwater, marine and brackish water habitats In some cases guidance is given on the construction of what would otherwise be expensive pieces of apparatus To get the best out of this book, the student should be given considerable help by his teacher So much is packed into it that many students let loose with it will suffer ecological indigestion

On modern standards the price is reasonable, for in my opinion this book should have a major effect on the teaching of animal ecology in schools

J B CRAGG

THE FIRST MINISTER FOR SCIENCE

By the Right Hon. VISCOUNT HAILSHAM, Q.C., LORD PRIVY SEAL AND MINISTER FOR SCIENCE

THE proposal for a Minister for Science was first talked about when the Conservative Manifesto was being prepared. I was myself at first very sceptical. It seemed to me that there were two very great pitfalls to be avoided. On one hand there was the danger that the scientific world—the Royal Society, the universities, the industrial scientists, the Atomic Energy Authority and the Research Councils—the Department of Scientific and Industrial Research, Medical Research Council and Agricultural Research Council, Overseas Research Council and Nature Conservancy (the governing boards of which are very largely manned by volunteers)—would think that too much was intended, and that the new Minister would interfere with the independence and integrity of the scientist in his own sphere. If that danger were not avoided, I feel that I should lose the confidence of those on whom all else depends and whose co-operation I must win if I am to succeed at all. I hope and believe my appointment has allayed these fears. After all I am the same man who has been Lord President of the Council for the past two years. My general attitude to science and scientists has been made plain to those who were interested, and I believe has won confidence. No change in that general attitude is involved in the new appointment. I have no authority over the universities to compel them to do anything they do not wish to do. My authority over the Atomic Energy Authority and the Research Councils is no greater than my predecessors and I had before, and I have no intention of taking away from them the authority which Parliament has given to them, or the freedom which they now enjoy to perform their functions without detailed interference. I am there to give them general guidance and to help them in their relations with Government, especially other Government departments.

But an equal and opposite danger is to be expected at this point. I can almost hear the cynical comment: "New Presbyter is but Old Priest writ large. The Manifesto promise, the new Minister, is just a piece of political window dressing. Nothing more is to be expected and everything will go on exactly as it was before." I hope and believe this is a mistake, and I would not have accepted the appointment had I believed otherwise.

All the same, I would like to make it plain at the outset that this is a long-range project. You must not expect clutches of satellites to be flung into orbit in a miraculously short space of time. Sponsors of ingenious inventions will be disappointed. The Minister is not a repository of brilliant new thoughts which have failed to appeal to anyone else. He is not an overlord to the Minister of Education and will not therefore be able to create vast new academies of science and technology. He is not "Master of the Queen's Rockets" and will not therefore play a decisive part in the politics of guided missiles. He is not a super Minister of Power nor a Minister of Transport, Agriculture or Health. Indeed, I must emphasize that unless all the other Ministers in the Government—I think without exception—are at least as scientifically minded as I ought to be myself, my work will be frustrated—and until they are my work will be incomplete. I do not think it is necessarily a disadvantage that I am not a professional scientist. The First Lord of the Admiralty is not a naval officer; the Minister of Transport would not necessarily be better for being a railway man. In the main, parliamentary government is government by amateurs advised by experts. The one exception is the Lord Chancellor, and he has a technical legal job to do. In my own case I believe that the appointment of a non-scientist as the first Minister will compel scientists to do the most urgent thing, that is, to share in the thought about scientific policy themselves.

For, whether or not there is need for a Minister or a Ministry, two years experience as Lord President has convinced me that there is need for a policy for science and that policy cannot be the product of Government thinking alone.

In describing my task I will start by one or two general propositions. Science in Great Britain increasingly touches life at every point. It is thus necessarily a partnership—and, since Britain is a democracy, it is necessarily a partnership in which everyone is invited to play a part. But the indispensable partners are industry, agriculture, medicine, teaching, the universities and Government—and, of course, both the scientists and the non-scientists who play their part in the administration of the various branches of public and economic life. In all these spheres my task is to promote science. But only in part of one of these spheres of activity—that of Government—have I the power to achieve this by the use of authority as distinct from encouragement, diplomacy, enthusiasm, example, precept or advice.

Secondly, after two years as Lord President of the Council, I would say that, if only because of the very multiplicity of scientific disciplines, Government science, and perhaps all British science, is at the moment too parochially minded, too departmentalized and lacking in the broader vision. The Research Councils and the Atomic Energy Authority are by their very terms of reference limited in their spheres.

However, a Minister for Science is bound to look for a more generalized philosophy and approach if he is to succeed. In some ways the focus of scientific opinion in Great Britain is the Royal Society. Long may it flourish. But for the purpose of advising the Government on scientific policy, the proper channel already exists in the form of the Advisory Council on Scientific Policy. I believe that this body provides one of the keys to the present situation, composed as it is of a unique connexion of Government and non-Government scientists under an independent chairman with a vice-chairman who happens also to be the chairman of the Defence Research Policy Committee. I shall endeavour to rely more than ever upon this Advisory Council for generalized advice on questions of scientific policy My purpose is to make the voice of science coherent and articulate under Government encouragement, and in one real sense to make science self-governing under Government inspiration For this purpose a greater use of the Advisory Council on Scientific Policy is inevitable I had already begun to move in this direction in the last Parliament I hope to go further now, and I feel I am going to be helped by the more flexible and numerous office staff (which supplies the secretariat of the Advisory Council) with which I shall be equipped as the result of the marriage between the Atomic Energy Office and the Lord President's Office Thus assisted I shall try to tackle such questions as whether the general balance of scientific effort is right or could be better deployed, and other questions of a general nature as they emerge Already in the last Parliament I had pressed forward an inquiry under the late Sir Claude Gibb (now chaired by Sir Solly Zuckerman) on techniques of management and control of Government financed research and development, and I look forward to a report from them, with positive suggestions, when they have completed their heavy task

One of the matters I referred to the Advisory Council on Scientific Policy in the last Parliament was the question of space research, and it was as a result of its advice that the Steering Group under Sir Edward Bullard was set up and the group of scientists under Prof H S W Massey paid their recent and successful visit to the United States I am not sure that either the philosophy or scope of our policy on space research is yet fully understood, and I would welcome the opportunity of expounding it more fully should questions be directed to me

I also have great hopes of the Overseas Research Council which I set up at the end of the last Parliament under the chairmanship of Dr R S Aitken The object of this body is to act as a sort of clearing-house for our research effort overseas both separately and in co-operation with other countries

I also hope to show a personal interest in the applied research which is very widely carried out by private industry and in industrial research associations under the general authority of the Department of Scientific and Industrial Research But execution of all this work will continue to rest with the bodies entrusted by Parliament with those functions

In many ways the clue to the picture of science in Britain lies with the universities—especially with those which have great potentialities for growth and indeed an increase in numbers To explore this in any detail would be outside my present purpose and indeed outside my function as the Minister for Science I have no authority over the universities nor over the University Grants Committee, and I have no ambitions to obtain such authority But I shall try to forge friendly links with both, both personally through individual contacts, and by discussions between officials In particular, I have ideas for the forging of closer links between the Government research stations and institutes, and the universities, from which I believe both the Government stations (and the scientists who work there) and the universities would stand to gain in prestige and in effectiveness

I also believe that the time has come for the purse strings of private munificence by industries and industrialists to be opened again for the benefit of universities and colleges and I will do all in my power to produce interest in this My object here is not to limit the amount of Government help, but to widen the front of public interest, and increase academic independence and flexibility It would be ungenerous and at this time insensitive not to point in this connexion to the gifts rightly described as princely—including one particularly welcome from the Transport and General Workers' Union, to Churchill College and to the project for St Catherine's reconstitution at Oxford But, greatly daring, may I say that I do not see why gifts from individuals and institutions should be concentrated on Oxford and Cambridge or even London ? The greatest scope for enlargement and improvement surely lies elsewhere, as other generous and far-sighted benefactors have recognized

The teaching of science and mathematics in the schools is again not a matter for me but for the teaching profession, and my contact with that profession must be through the Minister of Education , but I hope to keep a close liaison with the Minister in this and other matters, and I shall also try to seek guidance from the representatives of independent schools

It is clear, I think, that in a single term of office only the foundation can be laid of a genuinely scientific approach to the problems of the present day I hope that my ambitions in this direction will not be despised as inadequate because they are realistic and long-term My hope will be to engender in all a genuine enthusiasm for science, and respect for scientific work and scientists , not merely for their practical achievements, but also for the cultural values they represent If I win their confidence, and also make clear to the public and to my colleagues the nature of their needs and their outlook, I will not have failed Above all, I would like to say that I bring to this new and creative work all the enthusiasm and desire to serve of which I am capable, and a real determination to see that British science continues to be an instrument of peaceful progress and a means of enhancing British prestige in the world and British prosperity and culture

ROCKET PROPULSION

AT the meeting of the British Association in York, one of the sessions in Section B (Chemistry), on September 8, was devoted to a series of papers and discussions about various aspects of rocket propulsion

The subject was introduced by Dr W B Littler, director-general of Scientific Research (Munitions), Ministry of Supply, who outlined the history of rocket development He referred to the early use of gunpowder for rocket propulsion and the introduction in the Second World War of a variety of rocket weapons made possible by the development of new solid and liquid propellants The German *V*2 rocket, with a range of 200 miles and a payload of 1 ton, was the outstanding technical triumph of its day Since the War, vast sums of money have been spent, particularly by the Americans and Russians, on all forms of missile research and development The all-up weight of some rockets has surpassed the 100-ton level, and a range of 5,000–6,000 miles is claimed for some ballistic missiles In relation to the resources and man-power employed, some impressive successes have been achieved in the United Kingdom, and important developments have been pioneered with solid and liquid propellants and with the motors associated with them

The index of propellant performance most frequently quoted is the 'specific impulse' The solid and liquid propellants now in common use have a specific impulse in the range 180–250, compared with the figure of only 60 for gunpowder Substantial increases in specific impulse are possible by the use of uncommon fuels and oxidants (for example, hydrogen and fluorine) but most military applications can be met by the use of conventional propellants, and these are adequate for putting artificial satellites into orbit The most spectacular advances in recent years have arisen from three developments (1) the substantial increases in the size of the rockets and the weight of propellant carried, (2) the perfection of the multi-stage rocket, whereby motors are discarded successively in flight, after all the propellant has been burnt, thus eliminating dead weight as quickly as possible, (3) the development of very large solid-propellant motors containing up to ten or more tons of propellant

Unlike liquid-propellant motors, the thrust of solid-propellant motors cannot yet be controlled in flight, but they are basically simpler for many applications and can be more easily maintained in a state of readiness As a result, their use has greatly extended in recent years, but there is a future role for both types of propellant For controlled flight in outer space, much higher performances, not attainable with chemical systems, are required

The first paper, "Thermodynamic Aspects of the Choice of Rocket Propellants", by Mr G K Adams, of the Explosives Research and Development Establishment, Waltham Abbey, discussed the relation between the thermodynamics of propellant ingredients and combustion products and the performance of rocket propulsion systems Applying the principle of conservation of momentum to a rocket in a force-free field, it can be shown that the velocity increment v is given by $v = \bar{V}\ln(M_1/M_2)$, where $\bar{V}$ is exhaust velocity of the combustion products, M_1 is initial mass of rocket, and M_2 is mass of rocket after all the propellant has burnt The exhaust velocity is used as an index of propellant performance It is generally quoted in the form of the 'specific impulse', which is the quotient of the exhaust velocity and the force-to-mass conversion factor, and has the dimensions of time

By applying the principle of conservation of energy, the square of the exhaust velocity can be shown to be proportional to the decrease in total enthalpy per unit mass on burning the propellant under rocket conditions It depends, therefore, on the initial chemical energy of the propellant and on the efficiency with which this is converted into translational energy in the exhaust jet

The demand for high chemical energy per unit mass suggests the choice of elements of low atomic weight, suitable oxidation-reduction reactions between these have energies in the range of 2–4 kcal /gm The energies of reactions between free atoms or radicals are much greater, but owing to their high reactivity even at extremely low temperatures, there appears to be little hope of utilizing them in propulsion systems Other factors in addition to those of energy must also be taken into account Thus a propellant must have adequate chemical stability, its physical properties must be suitable for the particular application, and the materials used in the construction of the combustion chamber must be able to stand up to the temperatures attained In practice, such factors tend to limit the range of useful chemical energies still further, and in these circumstances particular attention must be paid to achieving the most efficient conversion of chemical energy into translational energy of the rocket

The efficiency of the expansion process is governed by a number of considerations A low total heat capacity per unit volume of gaseous products is beneficial, this leads to a requirement that the gaseous products shall contain the minimum number of constituent atoms (for example, HF rather than H_2O), lower efficiencies result if solid products are formed Energy released by shifts in chemical equilibria during expansion can be used less efficiently than that released in the chamber Energy is lost through the non-attainment of velocity and thermal equilibria in systems giving solid products Chemical energy alone, therefore, is not an adequate criterion for the choice of propellant systems A change which increases the efficiency is often more useful than a mere increase in chemical energy Additional factors which have to be taken into account are cost and availability

Mr J E P Dunning, director of the Rocket Propulsion Establishment, Westcott, then spoke about "The Application of Liquid Propellants to Rockets" He referred to some of the more important ballistic equations and described the physical processes involved in a rocket engine using a liquid fuel (for example, kerosine) and a liquid oxidant (for example, oxygen) A steady pressure is maintained in the combustion chamber by feeding in the liquids at the same mass flow-rates as the gases are ejected from the nozzle The propellants are pumped into the head of the combustion chamber through a multiplicity of orifices designed to establish as quickly as possible a uniform mixture of fuel and oxidant Both liquids must be vaporized and this is brought about by atomization, initiated by the actual process of injection and accelerated by the combustion of preceding droplets Once established, the combustion process is self-supporting but has, however, many tendencies to instability Satisfactory geometry of the chamber and injection head is essential to reduce these irregularities to a minimum, but the nature of the problem is such that the empirical approach still has to be largely relied upon

In the case of a liquid oxygen/kerosine motor developing 100,000 lb thrust, it is necessary to feed liquid into the chamber at a rate of about 400 lb /sec, of which 280 lb /sec will be liquid oxygen and 120 lb /sec will be kerosine The injection head may have as many as 2,400 orifices each 0 1 in in diameter, from which the liquids emerge at about 100 ft /sec Within an axial distance of about 1 ft, and a time of 2–3 millisec, the physical processes of atomization, vaporization and chemical reaction have to take place In the combustion chamber the temperature attains 3,300° K and the pressure 500 lb /in ^{2}, and the gases emerge at a velocity of around 8,000 ft /sec The temperatures attained are such that the walls of the chamber and the nozzle have to be cooled, and either fuel or the oxidant is used for this purpose To feed the liquids into the injector head two turbo-pumps are used, since the alternative system of pressurizing the tanks is ruled out by considerations of weight The pumping power required is large, but is achieved with a propellant consumption of rather less than 2 per cent of that used in the combustion chamber

In selecting possible fuel/oxidant combinations, performance merits may be over-ridden by criteria such as toxicity, availability and cost A limit on overall performance may thus be imposed, but this can be countered by increasing the mass ratio (mass at launch/mass at 'all-burnt'), although with a single-stage rocket it is not practicable to exceed a ratio of about 14 to 1 Enhanced performance can then only be achieved by the use of multi-stage propulsion systems

Dr G H S Young, of the Explosives Research and Development Establishment, Waltham Abbey, then dealt with British solid propellants for rockets He pointed out that all solid propellants are explosives and, under appropriate conditions, can be detonated These conditions must be avoided during manufacture and use, and this consideration frequently limits what can be achieved practically

The two main solid propellants in use in Britain are extruded cordite, sometimes called double-base propellant, and plastic propellant The extruded cordites are similar chemically to gun propellants and are available in a wide range of sizes and burning-rates In general, the burning-rate is adjusted by altering the calorimetric level, the more energetic the composition, the faster it burns The size of charge which can be produced is limited by the size of the presses available and the hazards involved with large quantities However, the double-base system has been recently extended by the exploitation of a casting process in which the nitrocellulose is gelatinized in a mould by desensitized nitroglycerine, the charge then being cured at 140° F for some days In this way charges larger, and more complex in shape, than those capable of extrusion are being produced Both extruded cordite and cast double-base are used as loose charges in the rocket motors

Plastic propellant, however, being a putty-like material, is capable of case-bonding, since the material can accommodate the differential thermal expansion between the motor wall and the propellant itself This type of propellant has been developed to make use of ammonium perchlorate as the oxidizer Burning-rates are adjusted by the addition of ammonium picrate and, as with extruded cordite, the lower-energy compositions burn more slowly than those of high energy This propellant has been successfully used in the largest British solid-propellant rocket to date, namely, that used in the *Skylark* in the International Geophysical Year experiments, this rocket has a charge of about 1,800 lb of propellant and is 17 in in external diameter

Another solid propellant being investigated is the so-called pressed charge, pioneered by Nobel Division of Imperial Chemical Industries, Ltd In this propellant the ingredients are consolidated to rock-like form by powerful presses Ammonium nitrate is the oxidizer, and propellants with low rates of burning, particularly suited for assisted take-off units and for gas generators, are produced

The present trend is for rockets to increase in size, and none of the propellants mentioned, with the possible exception of cast double-base, is altogether suitable for large missiles Work is therefore proceeding on other castable composite propellants based on synthetic rubbers and, of these, polyurethanes appear to have many advantages There is also a demand for higher performance and this can only be achieved by the introduction of novel ingredients, such as light metals, or new combustion systems which might, possibly, be based on fluorine compounds In addition, if solid propellants are to be used in the larger missiles, then methods of thrust control and thrust termination will need to be developed and the reliability of operation will have to be very high

Finally, Dr L R Shepherd, of the Atomic Energy Research Establishment, Harwell, and chairman of the British Inter-Planetary Society, spoke about propulsion for space travel The equation mentioned earlier represents an idealized condition and in the actual case of a rocket accelerating from the surface of the Earth the actual velocity may be 1,000–2,000 metres/sec less than the value predicted by this equation on account of atmospheric resistance and other effects For even the most modest excursion into space the limitations of conventional propellants demand the use of multi-stage rockets Using available chemical propulsion systems in staged rockets, it should be possible to put 20-ton payloads into orbit around the Earth or to deposit 1–2 tons of instruments on the Moon But for any more ambitious mission, propellant systems of much higher performance are required

Dr Shepherd considered that the difficulties involved in the application of reactions between free atoms or radicals (mentioned by Mr Adams) made it seem unlikely that these can be successfully applied to a practical propulsion system

Another possibility is the utilization of forbidden transitions between excited and ground states in the electron shells of certain atoms, for example, helium If the active material can be stored and its energy released in the thrust chamber of a rocket engine, the potential usefulness of a small single-stage vehicle is enormously extended It may be that the storage of active helium at low temperatures is more feasible than that of atomic hydrogen

Speculations on the application of nuclear power to rocket propulsion generally assume that the energy from a nuclear reactor can be transferred to a suitable working fluid, the optimum material being hydrogen This might be achieved by heating the working fluid in a thrust chamber and allowing it to expand through a nozzle in a manner similar to conventional practice Alternatively, the working fluid may be ionized and accelerated as a plasma in a magnetic field There are many formidable technical problems to be overcome before such nuclear systems can be developed

The use of electrical methods of propulsion has also been proposed This would involve an arc discharge to heat a working fluid and expand it through a nozzle, or, to avoid excessive temperatures, the electrical acceleration of a working medium It is generally assumed that this would be effected by ionizing the working fluid, extracting the positive ions, and accelerating them through an electrostatic field Alternatively, a fully ionized plasma may be accelerated in an electromagnetic pump

The working medium of such a system would probably be one of the alkali metals, possibly sodium At a temperature of 3,500° K and a pressure of 10^{-6} atmospheres, a sodium plasma is 95 per cent ionized, there should therefore be little difficulty in producing and maintaining such a plasma

It is known that a great deal of development work on novel propulsion systems is being carried out in the United States and presumably also in the U S S R

In the discussion, Prof M Stacey expressed interest in the possibility of using fluorine in propulsion systems The high toxicity of the combustion products was cited as a fundamental difficulty, and costs would also be high In reply to questions concerning the relative reliability of liquid- and solid-propellant motors, it was pointed out that there is very little information to support an absolute comparison A liquid-propellant motor, being more complex, might be expected to have a greater rate of failure, but the opinion of many British workers is that, given adequate attention in the research and development phases, the reliability of liquid-propellant motors should at least approach that of corresponding solid-propellant motors Questions were also raised regarding the role of solid 'cigarette burning' charges in view of the desire for high loading densities for propellants It was explained that the application of this type of charge to larger motors is limited by the need for high burning-rates and the additional insulation necessary to protect the motor wall which is exposed to the hot combustion products as burning proceeds These factors rob the 'cigarette burning' charge of its immediate attraction

W B LITTLER

DENSITY OF THE UPPER ATMOSPHERE FROM ANALYSIS OF SATELLITE ORBITS: FURTHER RESULTS

By D. G. KING-HELE
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IN an article on this topic in *Nature* some months ago[1], a new method of determining air density from the rate of contraction of satellite orbits was described and applied to the satellites launched during 1957 and 1958 In the present article the method has been refined by taking account of atmospheric rotation, and further results are given, utilizing the satellites of 1959, for heights between 180 km and 700 km The variation of density with latitude and season, and day-to-night changes, are also discussed

The rate of decrease of the orbital period of a satellite, which can readily be measured, depends on the integrated effect of air drag around the orbit The drag is greatest at perigee, and for a given satellite it is the air density at heights a little above that of perigee which chiefly controls the drag effects and which can best be estimated from the rate of change of period, $\mathrm{d}T/\mathrm{d}t$

Method of Analysis

It is assumed, first, that the drag D acting on a satellite of mean cross-sectional area S, moving with velocity v relative to the centre of the Earth, in air of density ρ, may be expressed in terms of a drag coefficient C_D as

$$D = \tfrac{1}{2}\rho v^2 FSC_D \qquad (1)$$

where SC_D may be taken as constant, and the factor F is included to allow for the fact that v differs from the velocity V of the satellite relative to the ambient air F, which is equal to $(V/v)^2$, may be taken as

$$F = \left(1 - \frac{r_p w}{v_p} \cos i\right)^2 \qquad (2)$$

where r is distance from the centre of the Earth, suffix p denotes perigee, w is angular velocity of the atmosphere (taken equal to that of the Earth) and i is inclination of orbit to equator For almost all the satellites so far launched, F has been between 0 9 and 1

The second assumption is that the density ρ at heights above that of perigee may be taken as varying exponentially with height y, so that

$$\rho = \rho_p \exp\{-(y - y_p)/H\} \qquad (3)$$

where H, which is approximately equal to the scale height, is taken as constant The value of H is not known accurately at heights above 180 km , but, if H^* is the best estimate of H, the density at a height $\tfrac{1}{2}H^*$ above perigee, ρ^*, can be expressed in terms of $\mathrm{d}T/\mathrm{d}t$ by the equation

$$\rho^* = -\frac{0\ 158}{\delta}\frac{\mathrm{d}T}{\mathrm{d}t}\sqrt{\frac{e}{aH^*}}\left\{1 - 2e - \frac{H^*}{8ae} + 0\left(e^2, \frac{H^2}{a^2e^2}\right)\right\} \qquad (4)$$

where $\delta = FSC_D/m$, m is the mass of the satellite, a is the semi-major axis and e the eccentricity of the orbit If $0\ 02 < e < 0\ 15$ and H^*, the best estimate of H, does not differ from the true value of H by a factor of more than 1 5, the maximum error in the expression (4) for ρ^* is less than 5 per cent If e is increased to 0 2, the maximum error is 10 per cent Equation 4 is the same as equation 5 of the previous article, except that SC_D/m has been replaced by FSC_D/m The introduction of the factor F allowing for atmospheric rotation changes the resulting values of density by 5–10 per cent, and the change is always an increase, since no satellite has yet (September 1959) been launched against the rotation of the Earth

When $e < 0\ 02$, equation 4 becomes less accurate, and for $0\ 005 < e < 0\ 02$, can best be replaced by

$$\rho^* = -\frac{0\ 0644}{\delta a}\frac{\mathrm{d}T}{\mathrm{d}t}\frac{\exp(ae/H^*)}{I_0(ae/H^*)}\left\{1 + 0(e) + 0\left(\frac{H}{a}\right)\right\} \qquad (5)$$

Table 1 VALUES OF $\delta = FSC_D/m$ FOR SATELLITES 1957α–1959ζ

Satellite		Mass m (kgm)	m/SC_D (kgm /sq m)	δ (sq m /kgm)
Sputnik 1	1957 α 2	83 6	110	0 0088
Sputnik 1 rocket	1957 α 1	—	63	0 015
Sputnik 2	1957 β	—	59	0 016
Explorer 1	1958 α	14 0	23	0 039
Vanguard 1	1958 β 2	1 47	23	0 040
Explorer 3	1958 γ	14 1	23	0 039
Sputnik 3	1958 δ 2	1,327	207	0 0046
Sputnik 3 rocket	1958 δ 1	—	63	0 015
Explorer 4	1958 ε	17 5	29	0 032
Atlas	1958 ζ	3,960	28	0 032
Vanguard 2	1959 α 1	9 75	20	0 044
Vanguard 2 rocket	1959 α 2	23	18	0 050
Discoverer 2	1959 γ	635	48	0 021
Discoverer 5	1959 ε	635	48	0 021
Discoverer 6	1959 ζ	635	48	0 021

where I_0 is the Bessel function of the first kind with imaginary argument, of order zero

Evaluation of δ

The main difficulty in applying equations 4 and 5 lies in the evaluation of δ ($= FSC_D/m$), and in particular of SC_D It is assumed here, as in the previous article, that each satellite rotated about its axis of maximum moment of inertia For satellites with length/diameter ratio greater than about 2, the extreme modes of rotation are then (*a*) travelling exactly like an aeroplane propeller, and (*b*) tumbling end over end In (*a*), the axis of spin and the direction of motion are in line , in (*b*), the angle between them is 90°, in practice, the angle may be anywhere between these extremes, and the mean of the values of SC_D for all modes of motion between (*a*) and (*b*) has been taken, the drag coefficient being calculated for free-molecule flow with diffuse reflexion

For near-cylindrical satellites, such as *Explorers* 1, 3 and 4 and *Atlas* (1958 α, γ, ε and ζ), SC_D has been taken as 1 85 λd, where λ and d are the effective length and diameter, the maximum possible error being 19 per cent A recent study[2] has shown that a rotating cone of length λ and base diameter d, and of shape similar to *Sputnik* 3 (1958 δ 2), has SC_D = 1 43 λd under mode of rotation (*a*), and 1 45 λd under mode (*b*), corresponding to drag coefficients (based on the appropriate mean cross-section) of 2 18 under mode (*a*) and 2 09 under mode (*b*) A drag coefficient C_D of 2 15 based on the mean of the cross-sections under modes (*a*) and (*b*) has been taken here For the spherical satellites, *Sputnik* 1 and *Vanguards* 1 and 2 (1957 α 2, 1958 β 2 and 1959 α 1), C_D has, as before, been taken as 2 2, based on the mean cross-section, including antennæ The values of δ for *Sputnik* 2 and the rockets of *Sputniks* 1 and 3 have been obtained by comparison with *Sputniks* 1 and 3, as explained previously[1] For the *Discoverer* satellites, which are cone-cylinders, δ has been taken as the mean of the cross-sections under modes (*a*) and (*b*), with C_D = 2 2

Table 1 lists the values of δ obtained for all the satellites launched before September 1959 whose orbits are known, except *Explorer* 6 (1959 δ), to which the theory is not applicable, since e is greater than 0 2 The values for the *Discoverers* apply during the period after the ejection of the re-entry capsule If the assumptions already stated are justified, the error (standard deviation) in the tabulated values of δ will probably be rather less than 10 per cent

Evaluation of Air Density

The air density at height $\frac{1}{2}H^*$ above perigee has been found for each of the satellites listed in Table 1 from equation 4 (or, for *Discoverer* 2, equation 5), the values of H^* chosen being consistent with those given later in this article For the Russian satellites, values of dT/dt, a and e have been taken from orbital

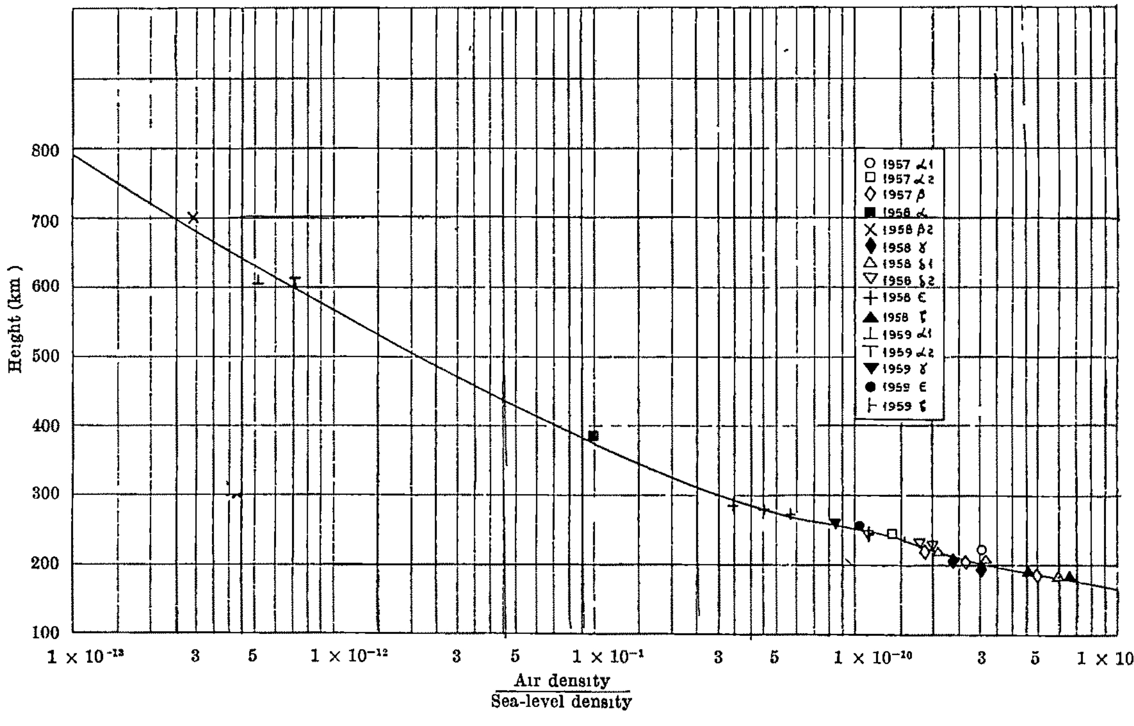

Fig 1 Air density obtained from satellites 1957α to 1959ζ

determinations made in Britain[3–6] For the U S satellites, values have come from the orbital data issued by the Smithsonian Astrophysical Observatory and by Project Space Track, Bedford, Mass For satellites with long life-times, the values of dT/dt have been averaged over intervals of several months

The resulting values of air density are shown in Fig 1, and a curve has been drawn through the points to represent average density It is worth noting that the individual points lie close to the curve, except for *Sputnik* 1 rocket, for which, however, the orbital information is rather meagre None of the other twenty points in the cluster below 300 km differs from the curve by a factor of more than 1 25 Some scatter is to be expected, because of the errors in δ and because the density varies from week to week by up to 30 per cent at 200 km height[7] and by 50 per cent or more at 700 km [8] Because of the latter variations, and because of the possible influence of charged drag[12,13], the three points above 500 km are less reliable than those below

The value of $6 7 \times 10^{-15}$ gm /c c for air density at 440 km , deduced[14] from the rate of expansion of a cloud of sodium vapour from the Russian Geophysical Rocket of February 1958, differs from the curve of Fig 1 by a factor of less than 1 25, and fills a gap in a rather empty region

Variation of Density with Latitude and Season

The points plotted in Fig 1 refer to latitudes ranging between 70° N and 50° S , and to all seasons , but there is no sign of any systematic variation of density with latitude or season In view of the small scatter, it seems probable that the density at a given height below 300 km does not depart from its average value by a factor of more than about 1 5 as a result of variations with latitude (between 70° N and 50° S) and with season This is in contrast with the direct measurements from rockets[15,16], which suggest a much wider variation, by a factor of 5 or even 10 , so it is worth seeking further evidence

Such evidence can be obtained from the orbit of *Sputnik* 3 between May 1958 and June 1959 During this time, the perigee latitude moved slowly from 50° N to 65° S , and the perigee height changed by less than 20 km The rate of change of period of *Sputnik* 3 thus provides a continuous indication of the air density at heights between 200 and 250 km , and over the range of latitude from 50° N to 65° S The air density ρ_p at the current perigee height was calculated from the equation[17]

$$\rho_p = -\frac{1}{3\delta}\frac{dT}{dt}\sqrt{\frac{2e}{\pi a H}}\left\{1 - 2e - \frac{H}{8ae}\right\} \qquad (6)$$

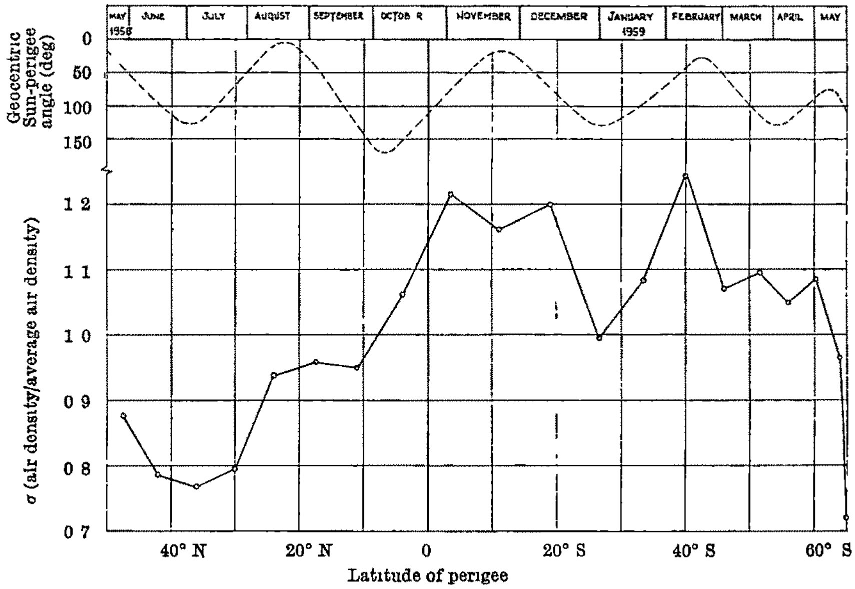

Fig 2 Air density at the initial perigee height of *Sputnik* 3, 226 km variation with latitude and time

with H = 30 nautical miles (56 km) The values of dT/dt were obtained from the records of orbital period kept by the Royal Aircraft Establishment (May–October 1958) and the Radio Research Station, Slough (October 1958–June 1959) The density at the initial perigee height y_{po} (226 km) was then found by multiplying ρ_p by $\exp\{-(y_{po} - y_p)/H\}$, where y_p is the current height of perigee over an oblate Earth This process gives the air density at the *initial* perigee height (226 km), but at latitudes near the *current* perigee latitude The resulting densities, calculated at 20-day intervals and expressed as a multiple σ of the average density, are plotted against perigee latitude in Fig 2 A satellite encounters drag over a range of latitudes near perigee, and each point in Fig 2 represents an average density over the 15–20° of latitude within which most of the drag effect occurs, rather than the density at the exact latitude where it is plotted Consequently, there is no virtue in reducing the time-interval between the points in Fig 2

The chief errors in σ are likely to result from errors in dT/dt (estimated standard error 3 per cent), H and $y_{po} - y_p$ (estimated bias errors 20 per cent each) and δ (maximum error[2] 5 per cent) The estimated standard errors in σ from these four sources are 3, 2½, 2½ and 2½ per cent, respectively, implying a standard error in σ of about 5 per cent

The density at heights of 200–250 km is known to vary with time, by a factor of up to 1 3, exhibiting a 28-day periodicity, which is attributed to solar disturbances[7–11], and one of the reasons for choosing a 20-day interval in Fig 2 was to avoid giving prominence to the 28-day oscillations Fig 2 represents the combined variation due to solar effects, latitude, season, etc Since none of the values of σ differs from 1 by a factor of more than 1 4, and the standard error is about 5 per cent, Fig 2 strongly suggests that the density does not depart from its average value, as a result of seasonal and latitude effects, by a factor of more than 1 5, between latitudes 50° N and 65° S , thus confirming the evidence of

Fig. 1, it is very unlikely that strong seasonal and latitude variations do occur and happen to have cancelled out for *Sputnik* 3.

It would probably be unwise to draw any positive conclusions about the variation of density with latitude and season from Fig. 2, but the large drop at the right-hand end does encourage the speculation that the air density at heights of 200–250 km. may be low at latitudes south of 60° S., at least in the winter.

Day-to-night Variations in Density

The upper curve in Fig. 2 shows the angle SCP subtended at the centre of the Earth (C) by the Sun (S) and the perigee (P) of *Sputnik* 3. If this angle exceeds 90°, the surface of the Earth below perigee is in darkness; if the angle exceeds about 105°, the perigee point itself is in darkness. Comparison of the two curves in Fig. 2, though inevitably inconclusive because of the errors in σ, gives the impression that the air density is related to the angle between Sun and perigee, a possibility which has previously been suggested by Sedov[18], Lidov[19], Groves[20] and others. If so, the air density at heights of 200–250 km. is rather higher on the sunlit half of the Earth than on the dark half, and this day-to-night variation, which had a period of about 90 days for *Sputnik* 3, and an amplitude of perhaps ± 10 per cent, would be superposed on the 28-day variation due to solar disturbances, which had an amplitude of about ± 20 per cent. A rather similar interpretation for a height of 700 km. was recently proposed by Wyatt[21], from analysis of the orbit of *Vanguard* 1, though at this greater height the angle between the Sun and perigee is, on Wyatt's interpretation, more important than solar disturbances. There is also some slight indication of a day-to-night variation for *Sputnik* 2 and *Sputnik* 3 rocket, though the 28-day variation is dominant[7,8,11].

Values of H

The slope of the density-versus-height curve of Fig. 1 gives the value of the coefficient H in equation 3, and Table 2 lists values of density and of H derived from the curve. Other curves, of different slopes, could however be drawn in Fig. 1; the individual values of H in Table 2 might, therefore, be in error by up to perhaps 20 per cent, though the mean value of H between 200 and 400 km. height is almost certainly between 50 and 60 km.

The rather irregular values of H in Table 2 between 200 and 260 km. result from the indentation in the curve of Fig. 1. If, instead, a smooth curve were drawn, seven successive points, from six satellites of quite different shape, size and date of launch (*Explorer* 4, *Discoverers* 2, 5 and 6, and *Sputniks* 1 and 3), would lie on the same side of the curve. The indentation, therefore, seems justifiable, though it might still be illusory, if several points happened to be in error in the same sense.

If the indentation is real, it indicates a rather large value of H—more than 50 km.—at heights near 220 km., in accord with the values of H found from the decrease in the perigee distance of satellites[1,22]. The air temperature depends[1] on the product of H and M, the mean molecular weight of the air. So, unless M varies widely between 210 and 230 km., the indentation corresponds to a peak in temperature near 220 km. height, the maximum value being near 60 M °K. The value of M is not known exactly, but is probably near 20. Such a peak in temperature might imply the absorption of certain wave-lengths in the solar radiation at heights near 220 km., though this deduction must be regarded as speculative[23].

Table 2. Values of Air Density and H given by the Curve of Fig. 1

Height (km.)	Air density / Sea-level density	Density (gm./c.c.)	H (km.)
180	6.4×10^{-10}	7.8×10^{-13}	27
200	3.2×10^{-10}	3.9×10^{-13}	35
220	2.0×10^{-10}	2.5×10^{-13}	52
240	1.4×10^{-10}	1.7×10^{-13}	46
260	7.7×10^{-11}	9.4×10^{-14}	32
280	4.5×10^{-11}	5.5×10^{-14}	47
300	3.0×10^{-11}	3.7×10^{-14}	57
320	2.1×10^{-11}	2.6×10^{-14}	62
340	1.6×10^{-11}	2.0×10^{-14}	68
360	1.2×10^{-11}	1.5×10^{-14}	75
380	9.3×10^{-12}	1.1×10^{-14}	77
400	7.2×10^{-12}	8.8×10^{-15}	79
500	2.1×10^{-12}	2.6×10^{-15}	86
600	7.1×10^{-13}	8.7×10^{-16}	90
700	2.5×10^{-13}	3.1×10^{-16}	99

Conclusions

A consistent picture of the air density at heights between 180 and 700 km. is obtained from the orbits of 15 satellites (see Fig. 1 and Table 2). The picture is more complete and more reliable at heights below 500 km. than above. All the results refer, however, to the years 1957–59, and it is probable that the density varies in the course of a sunspot cycle. There is some indication of a peak in temperature near 220 km. height, but there is no sign that density varies with latitude or season by a factor of more than 1.5. Analysis of the motion of *Sputnik* 3 confirms this latter conclusion, for a height of 220 km., and shows some evidence of day-to-night variation in density.

I wish to thank Mrs. D. M. C. Walker for preparing the diagrams and tables in this article.

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NEWS and VIEWS

Nobel Prize for Chemistry for 1959

Prof Jaroslav Heyrovsky

PROF JAROSLAV HEYROVSKY, director of the Polarographic Research Institute of the Czechoslovak Academy of Sciences in Prague, has been awarded the Nobel Prize for Chemistry for 1959, for his discovery and development of polarography A native of Prague, he studied under Sir William Ramsay and F G Donnan in London before the First World War and then returned to Prague to continue his research work It is of interest that the work on the determination of the electrode potential of aluminium which led eventually to the development of the polarographic method was suggested to him by Donnan The first polarographic apparatus was made in 1925, but the method did not become widely recognized for a further decade, and Heyrovsky's major book, "Polarographie", did not appear until 1941 However, the number of papers dealing with polarography now approaches the 10,000 mark, and the technique finds application in many fields of chemistry and biochemistry , it has had a profound influence on analytical chemistry, for some determinations which are difficult or impossible to carry out by other means yield readily to polarographic treatment In addition, there have been made non-analytical applications For example, the kinetics of electrode reactions and of chemical reactions associated with redox processes have been studied, redox potentials have been determined and the energetics of the reduction of organic compounds have been elucidated Prof Heyrovsky has not enjoyed good health for some years, and is therefore prevented from accepting many of the invitations which he receives to lecture abroad The present award is a timely recognition of his great services to analytical chemistry, particularly as he will celebrate his seventieth anniversary next year

Glass Technology at Sheffield .

Mr Michael Parkin

WITH the retirement of Mr Michael Parkin, the Department of Glass Technology in the University of Sheffield lost its last member of that small team of pioneers recruited by Prof W E S Turner in the years immediately following the First World War to build up a department which has become world-famous Mr Parkin studied chemistry in the University of Sheffield , however, his studies were interrupted by war-time services in an explosives factory and in the Royal Flying Corps In 1920 he joined the Department of Glass Technology, and apart from a short period in industry (he was works chemist to Messrs Barr and Stroud, Ltd , 1924–28) he has served the Department continuously Until 1955 the Department performed dual functions, carrying out the work of a University department and advisory work and investigations for the industry under the advice of the Glass Delegacy, the members of which were roughly equally divided between the University and the glass industry Mr Parkin made a major contribution to this work This prevented his taking a direct personal responsibility for the research side of the work of the Department , but those whose responsibility it was to direct the research work would be the first to acknowledge the important part played by Mr Parkin in assisting research workers In 1955 the industrial work was taken over by the newly formed British Glass Industry Research Association, a step which Mr Parkin never pretended to approve, but, as all who know him would expect, he has, during these past four years, spared no effort to help the University Department in its new regime to flourish Perhaps the value which his present colleagues place on his services can best be emphasized by saying that he has been persuaded to continue as a part-time member of the staff for a short period while certain plans for future staffing of the Department mature

British Association Representatives in the U S.S.R

THE British Association for the Advancement of Science has accepted an invitation from the U S S R – Great Britain Society, conveyed through the Soviet Embassy in London, to send two representatives to the U S S R to visit schools, universities and scientific institutions, to meet Russian scientists and to discuss future relationships and exchanges The British Association's representatives are Dr W E Swinton, who is an honorary general secretary of the Association, and Sir George Allen, who is its secretary

European–American Nuclear Data Committee

A COMMITTEE for European–American Nuclear Data has been set up by the European Nuclear Energy Agency, in agreement with Euratom, the United States of America and Canada, to assure collaboration among members and associate countries of the Organization for European Economic Co-operation in the measurement of nuclear properties The Committee will be primarily concerned with measurements of nuclear cross-sections and other basic data essential for the technical development of nuclear energy The Committee is to consist of thirteen experts from the United States, Canada, the United Kingdom, the Euratom and other O E E C countries Its operations will be in accordance with existing bilateral agreements The work of the Committee will include the critical review of existing knowledge of nuclear cross-sections and constants, and of facilities, techniques and man-power available for their determination The Committee will also collect and correlate data from available sources, seek to establish a standard nomenclature and methods of presentation for such data, and recommend and sponsor, as necessary, technical meetings and symposia to further its objectives Finally, the Committee will promote the pooling and exchange, where appropriate, of equipment and personnel Further information can be obtained from the Organization for European Economic Co-operation, Château de la Muette, 2 rue André-Pascal, Paris XVI^e

New Forensic Science Society

A DECISION to form the Forensic Science Society was taken at a well-attended meeting held at the University of Nottingham on October 31 The object of the Society is to advance the study and application of forensic science in all its branches With this aim in view, a series of symposia, to be held alternately in London and in the provinces, is being arranged.

Among the subjects suggested for discussion are blood, hypoglycæmia, street accidents and instrumentation All persons professionally interested in forensic science are eligible for membership The president of the Society is Dr J B Firth, and the secretary Dr E G C Clarke, of the Royal Veterinary College, London, N W 1, from whom further information can be obtained

Preservation of the Malvern Hills

As a result of the confirmation, by the Minister of Housing and Local Government, Mr Henry Brooke, of an order made by the National Parks Commission under the National Parks and Access to the Countryside Act, 1949, about forty square miles of the countryside in the counties of Gloucester, Hereford and Worcester, including the whole of the Malvern Hills, are to be established as an 'area of outstanding natural beauty' The designated area extends from Knightwick in the north to Bromsberrow in the south and from Suckley, Cradley, Coddington, Wellington Heath and Ledbury in the west to Welland and Great Malvern in the east. It includes such well-known features as the Worcestershire Beacon, North Hill and the National Trust's property at Midsummer Hill The responsibility for preserving the landscape rests with the County Councils of Gloucestershire, Herefordshire and Worcestershire as the local planning authorities Government grants can be made at the rate of 75 per cent towards the cost of treating derelict land, tree planting and preservation and removing disfigurements Grants are also available towards expenditure incurred in making agreements or orders for public access to open country and in appointing wardens Designation does not provide any right of access to land not already open to the public Nor does it affect the existing use of land, such as the use of War Department land for military purposes

Newly Available Endocrine Preparations

THE Endocrinology Study Section of the National Institutes of Health has the following highly purified pituitary hormones available for distribution free to qualified investigators · growth hormone, bovine, non-sterile for animal experiments only, follicle-stimulating hormone, ovine, sterile preparation 25 mgm vials for experiment, 5 mgm vials for assay standard; luteinizing hormone, ovine, sterile preparation, 10 mgm vials, prolactin, ovine, sterile preparation, 25 mgm vials Further information can be gained from Dr R T Hill, Executive Secretary, Endocrinology Study Section, Division of Research Grants, National Institutes of Health, Bethesda 14, Maryland

National Science Foundation: Grants for Private Foundations in 1957

GRANTS made by the National Science Foundation for scientific research and development by private philanthropic foundations and voluntary health agencies totalled 95 million dollars during 1957, of which about 59 million dollars was in support of basic research (No 15, Reviews of Data on Research and Development National Science Foundation, Washington, D C) It is estimated that research expenditure for 1957 by private foundations and health agencies in the United States amounted to about 8 per cent of the estimated national basic research expenditure of 700–800 million dollars Expenditures for research and development by these institutions amounted to less than 1 per cent of the total expenditures for research and development by all organizations Of 4,067 private foundations surveyed, 438 reported research and development programmes, and a total expenditure of 72 million dollars Twelve foundations accounted for more than half this expenditure 82 per cent was in the form of grants and related administrative expenses to outside organizations The latter were predominantly educational institutions and their affiliated professional schools and hospitals One in five foundations with research and development programmes reported expenditure for research in their own laboratories or facilities The major part of support by foundations in 1957 covered the life sciences, accounting for 45 per cent of their total research and development expenditures The social sciences were next in volume of support, and the physical sciences last, according to the report Twenty-five of the thirty voluntary health agencies surveyed for 1957 reported expenditure for research and development, this amounted to 23 million dollars, of which almost one-half was for basic research. Four of the health agencies accounted for more than four-fifths of the total research expenditures, most of which were in the form of grants to outside organizations and individuals Educational institutions and affiliated medical schools and hospitals were the major recipients The voluntary health agencies concentrated almost exclusively on the support of biological and medical research.

Illuminating Engineering Society

AT the meeting of the Illuminating Engineering Society held in London on October 13, Mr H G Campbell was installed as president of the Society for 1959–60 Educated at Oundle and Queens' College, Cambridge, Mr Campbell is managing director of Benjamin Electric, Ltd, and a director of Holophane, Ltd The Leon Gaster memorial premium of the Illuminating Engineering Society for 1959 has been awarded to Dr R G Hopkinson and Mr J. Longmore (both of whom are with the Building Research Station of the Department of Scientific and Industrial Research) for their paper entitled "The Permanent Supplementary Artificial Lighting of Interiors".

U S. Society of Protozoologists

THE following officers, for the academic year 1959–60, were elected or appointed at the annual meeting of the Society at Pennsylvania State University, during August–September *President,* Dr Norman D Levine (University of Illinois), *Vice-President,* Dr. Reginald D Manwell (Syracuse University), *Executive Committee* (*new members*), Dr E R Noble (Santa Barbara College, California), Dr Charles Ray, jun (Emory University)

Mond Nickel Fellowships

THE Mond Nickel Fellowships Committee announced recently the award of a Fellowship for 1959 to Mr D J O Mann (John Lysaght's Scunthorpe Works, Ltd), to study the practical applications of recent metallurgical research and techniques to the production of basic semi-finished steel, and Mr. N J B Pocock (Capper Pass and Son, Ltd), to study developments in extractive metallurgy in the United Kingdom, Europe, the United States and Canada, and their dependence on the size and location of the organizations concerned

University News:

Hull

The Department of Scientific and Industrial Research has made a grant of £6,000 to the Department of Chemistry towards the purchase of a mass spectrometer in support of research by Dr G C Bond

The Nature Conservancy has made a grant of £4,900 to the Department of Geography for a three-year investigation into the coastal geomorphology of Holderness and Spurn Head

The following appointments to lectureships were made and took effect as from October 1 F J Bryant (physics) and I C Williams (zoology)

London

The following titles are announced that of professor of physics in the University of London, conferred on Dr M Blackman, in respect of his post at the Imperial College of Science and Technology, of professor of physical chemistry in the University of London, conferred on Dr F C Tompkins, in respect of his post at the Imperial College of Science and Technology, of reader in biochemistry in the University of London, conferred on Mr S P Datta, in respect of his post at University College, of reader in applied mathematics in the University of London, conferred on Dr C W Kilmister, in respect of his post at King's College

Oxford

Research grants are announced as follow · by the Medical Research Council, a grant not exceeding £1,100, for one year as from October 1, for scientific assistance in a study by X-ray analytical methods of insulin and related structures, to be carried out in the Laboratory of Chemical Crystallography under the direction of D M Hodgkin, reader in X-ray crystallography, by the United Kingdom Atomic Energy Authority, a grant not exceeding £5,700 for three years as from October 1, 1959, for studies in interferometric spectroscopy, to be carried out in the Clarendon Laboratory under the direction of H G Kuhn, also a further grant not exceeding £1,250 during the period October 1, 1959, to September 30, 1960, for work on the constitution of bismuth-rich alloys, being carried out in the Department of Metallurgy under the direction of Prof W Hume-Rothery, by the U S Public Health Service, a sum of 14,160 dollars for one year from September 1, 1959, for the continuation of research on vision and light quanta being carried out in the Department of Physiology by M H Pirenne, under the direction of Prof E G T Liddell

The Department of Scientific and Industrial Research has provided grants not exceeding £1,000 for one year as from October 1, 1959, for research on some natural products with biological activity, to be carried out in the Sir William Dunn School of Pathology under the direction of Dr E P Abraham, £1,500 for one year as from October 1, 1959, for research into perceptual limitations in high-speed performance in the Institute of Experimental Psychology by H Kay, under the direction of Prof R C Oldfield, £22,860 for three years ending September 30, 1962, for an investigation of the geological age of rock series by methods based on natural radioactivity, being carried out in the Department of Geology under the direction of Prof L R Wager, £1,220 for equipment for research on the biochemical mechanism of cell division, to be carried out in the Department of Biochemistry under the direction of Sir Hans Krebs, and £25,725 for the period October 1, 1959, to July 31, 1962, for an investigation of materials, using magnetic resonance and double resonance techniques, to be carried out in the Clarendon Laboratory under the direction of Prof. B Bleaney

The Admiralty has supplied, for the year ending March 31, 1960, a grant not exceeding £9,534 10*s* 0*d*, for the continuation of research on centimetre waves and fundamental problems being carried out in the Clarendon Laboratory under the direction of Prof B Bleaney, and the Ministry of Supply a grant not exceeding £1,175 for a year from September 1, 1959, for the continuation of an investigation of fluorocarbohydrates being carried out in the Department of Biochemistry under the direction of Dr P W Kent

Announcements

Mr F C Braby, chairman and managing director of Fredk Braby and Co, Ltd, has been elected chairman of the Council of the British Non-Ferrous Metals Research Association in succession to Dr Maurice Cook, who retires from that office on December 31

The Infra-Red Development Co, Ltd, Welwyn Garden City, has amalgamated with Hilger and Watts, Ltd, 98 St Pancras Way, Camden Road, London, N W 1 The Infra-Red Development Co was founded in 1946 and specializes in the analysis of gases by non-dispersive infra-red techniques, primarily for industrial purposes, it has been under the technical control and management of Mr W. B Bartley, who will remain managing director It will continue to operate at its works and offices in Welwyn Garden City

The well-known instrument makers, Griffin and George, Ltd, Ealing Road, Alperton, Wembley, Middlesex, are opening a new branch at 626 Welbeck Road, Walker, Newcastle upon Tyne To celebrate this step, two exhibitions are being held, at the Heaton Assembly Rooms, Heaton Road, Newcastle upon Tyne, during November 17–20, and at the Corporation Hotel, Corporation Road, Middlesbrough-on-Tees, during November 23–25 The exhibitions will show a representative range of equipment of the latest type for education, research and development and industry

Under the provisions of the Fulbright Programme, travel grants are available to citizens of the United Kingdom and dependent territories, to go to the United States for an academic or educational purpose, provided that they have adequate financial support in dollars for the visit, and have been accepted by an American institution of higher learning Grants cover the cost of direct travel between the candidate's home and the American university or institution They are available during June 1, 1960–August 15, 1960, for which applications must be submitted by March 14, 1960, and August 16, 1960–April 1, 1961, for which applications must be submitted by June 1, 1960 Application forms and further information can be obtained from the United States Educational Commission in the United Kingdom, 71 South Audley St, London, W 1

We regret that in the article entitled "Scientists in the Public Service in Britain" in *Nature* of September 19, p 858, the statement issued officially relating to Dr J W G Lund is incorrect Dr Lund is in charge of the algological research of the Freshwater Biological Association, of which Mr H C Gilson is director

BOOTS' NEW BIOLOGICAL RESEARCH LABORATORIES

By DR. G. I. HOBDAY
Director of Research

DURING a night-time air-raid on Nottingham in May 1941, nearly all the research facilities of Boots Pure Drug Co., Ltd., were destroyed. Blast and fire reduced virtually all the chemical and biological laboratories to heaps of charred rubble. The timing of this disaster could not have been more unfortunate. Under the stimulus of the national emergency we were expanding our research operations to enable the company to manufacture many vital drugs of European origin, supplies of which had been cut off by the War; penicillin, in the development of which we were to collaborate, was about to emerge. It was urgently necessary, therefore, to re-house our chemists and biologists as soon as possible. Because new construction was out of the question existing premises had to be converted. Choice of these was not easy since the Research Department was by no means the only one to suffer damage and every foot of space in the company's buildings in and around Nottingham was at a premium.

After due consideration, it was decided to re-house chemistry and biochemistry in a nearby building on the Island Street site and to evacuate the biological facilities, including bacteriology and pharmacology research and standardization, to a heterogeneous group of company buildings in West Bridgford, a Nottingham suburb. These latter, on which over the years a considerable amount of money has been expended, have served us well. Of course, it was evident from the beginning that they would answer our needs for only a limited period. But, as with many war-time expedients, building restrictions in the post-war years and the subsequent need to share out the capital cake among an increasing number of growing members of the company left us in occupation of them for longer than was originally intended. However, after about eighteen months of active planning we started construction of a new biological research building in September 1956, and occupation of it has just been completed.

The new building, which was designed by Boots' architectural staff, is sited in Nottingham a short distance away from the chemical manufacturing plant, but near enough so that services such as steam, electricity and water are drawn from the central works supply. It is near the present chemical and biochemical research laboratories and immediately adjacent to the site on which these facilities will be re-housed within the next few years. In plan, the building is in the form of an irregular H; one wing of four floors houses administration offices, Medical Department, library, canteen, conference room and a fully equipped lecture theatre seating 200; the linking block contains the main staircase and lifts together with lavatories and cloak-rooms; the other wing, longer than the first and on seven floors with a basement, is entirely laboratories. The total floor area is approximately 90,000 sq. ft. Externally, the building is of striking appearance; one wing is of brick and the other is faced with ceramic tiles in a checker-board pattern of grey and yellow. In internal design the administration wing and linking block are fairly conventional, but features of special interest include the pre-stressed concrete main staircase and the undulant ceiling in the canteen. The lecture theatre, which is acoustically designed, is fitted with stackable chairs which can be removed, entirely liberating the floor space for exhibitions, etc. Also to be noted is the pleasant medical and biological library housing 15,000 volumes, the stack room of which is fitted with mechanically operated stacking for economy of floor space. The décor throughout is modern, but not aggressively so, using mainly monochromatic treatments and avoiding disturbing colour contrasts. In the entrance lobby is a large colourful mural, abstract in design but intelligibly depicting the scientific disciplines provided for in the building.

The laboratory wing is functionally planned to accommodate the biological procedures employed, the common links throughout being laboratory animals and micro-organismal techniques. Required floor area and available site area comparison clearly pointed to a multi-storey building; this was quite acceptable, indeed in many respects desirable, since it permitted a plan of isolation of different functions on separate floors while reducing circulation distances

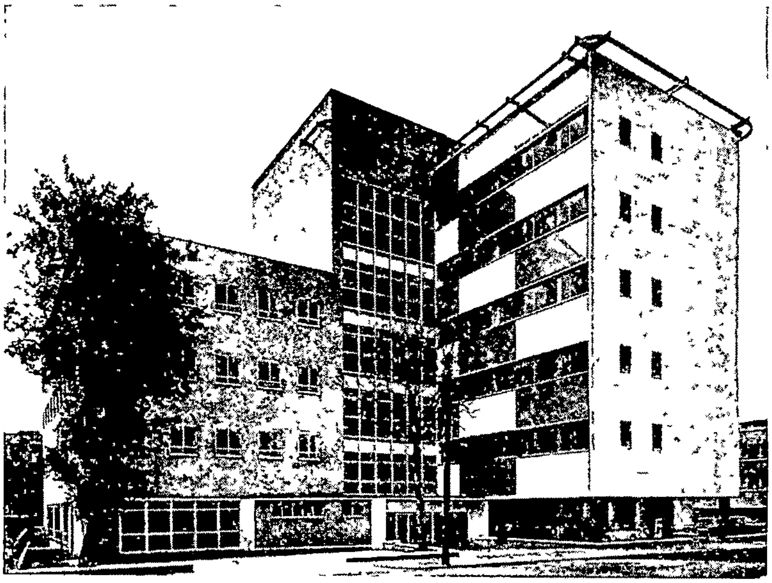

Fig. 1. Main entrance to Boots' Biological Research Laboratories. Administrative offices, library and lecture theatre are on the left; laboratories on the right

and simplifying centralized servicing The floors were planned on a 9-ft module in a block 200 ft long and 45 ft wide This plan gave a spinal corridor arrangement which again helped in the separation of functions, since it was easy to form the areas at both ends into isolation units A steel-framed building was chosen with space-frame girders 3 ft 6 in deep and 45 ft span By this arrangement none of the internal walls is part of the structure, permitting alteration of the working areas as the need arises ; it also provides a space between ceiling and floor above in which services are distributed Vertical distribution of services is through a duct, 10 ft by 17 ft , which goes right through the building from top floor to basement The whole of the laboratory wing is air-conditioned, inlet air being drawn in through an electrostatic precipitator and distributed through two separate systems, one serving the east side and the other the west side to give flexibility in taking care of solar gain through the large unopenable windows A plenum system is used with pressure differences carefully arranged especially in laboratories where micro-organisms are used All extracted air from areas of possible infection is filtered sterile before being vented to atmosphere Where necessary, 'hospital' finishes on walls and ceiling are employed to facilitate cleaning and sterilizing , floor coverings are sheet polyvinylchloride in laboratories and hard asphalt in animal rooms and wash-down areas Stainless steel benches and steel under-bench fittings are employed in all sterile areas and teak tops with wooden furniture elsewhere

Equipment cleaning and sterilizing are centralized in the basement, where all refuse is incinerated There are two systems of automatic hoists for handling separately dirty equipment to the basement and returning clean equipment to the requisite floors All equipment and material passing from the isolation areas are heat-sterilized before proceeding down the 'dirty' hoist Media-making is centralized and from a food store on the top floor animal diets are delivered to appropriate floors by chutes

Facilities for work with radioactive labelled substances are provided in a self-contained suite The main units of this are a synthetic chemical laboratory, a biological laboratory with separately vented cage cabinets and a radioactivity measurement laboratory The main radioactive store is in a shielded room in the basement

The work in the laboratories lies in the fields of pharmacology, toxicology, bacteriology, mycology, virology and parasitology Some routine testing and standardization work is done on chemical and pharmaceutical production material, such as sterility-testing of injections and bio-assay of insulin Otherwise the work is investigation, much of it comprising the biological component of research projects involving other research divisions For example, in the field of parasitology trypanosomiasis is a major project, and chemical substances synthesized in the nearby chemical research laboratories, or new antibiotics isolated in the antibiotic research unit, are screened in the new building by specialized laboratory tests Those of potential value will undergo more specific tests for activity and, in another unit in the building, for toxicity Any worthy of clinical or field trial will be passed over either to the Medical Department or to the veterinary research division at Thurgarton, about ten miles outside the city Work of this kind has produced 'Ethidium' and 'Prothidium' for treatment and prophylaxis of bovine trypanosomiasis In a similar way the parasitologists working on amœbiasis have contributed to the development of 'Entamide' for the treatment of amœbiasis Likewise the bacteriologists have collaborated with the chemists and pharmacists in developing a new antibacterial substance, 'Dybenal'

Team operations of this kind provide much of the impetus for progress in the search for new substances for the treatment of human, veterinary and plant diseases The new laboratories form a vital link in the chain of investigations between the first conception of a new drug and its final availability to the public They serve the future in providing the type of working accommodation which the young research scientists of to-day expect and need in order to make their most effective contributions in the fight against disease

THE BRITISH FOOD MANUFACTURING INDUSTRIES RESEARCH ASSOCIATION

THE British Food Manufacturing Industries Research Association Laboratories at Leatherhead were open to members on September 16 and to invited guests on the following day The wide range of the research programme of the Association was demonstrated, the exhibits covering work in progress for the eight main groups into which the membership is divided, that is to say, cocoa and chocolate, sugar confectionery, meat and fish products, jams and jellies, pickles and sauces, oils and fats (including margarine and compound cooking fats), bakers' prepared materials and miscellaneous products ranging from table jellies to salted nuts and potato crisps The work undertaken covers fundamental chemical, physical and bacteriological investigations alongside technological aspects of food manufacture

For the chocolate industry an item of major importance is the study of the rheology of molten chocolate An experimental viscometer was on show which had been designed and built to the requirements of the Association to give measurements of viscosity over a wide range of rates of shear A method of plotting the viscometric data has been developed which leads to the flow properties of chocolate being expressible in terms of two constants The glyceride composition of cocoa butter is being studied by chromatographic techniques Complete separation of the mono-unsaturated triglycerides has been achieved by reverse phase paper chromatography using a non-polar stationary phase and a suitably chosen mobile phase An investigation into the volatile constituents responsible for the flavour of cocoa and chocolate by gas chromatography is in its initial stage

The properties of high-boiled sweets, particularly their behaviour on exposure to the atmosphere, is being investigated by means of an apparatus which permits samples to be boiled under closely controlled conditions at low moisture content. The drying of certain types of confectionery deposited in starch moulds is being studied in two ways with the view of reducing the 'stoving time' necessary for their production. First, the effects of temperature and humidity on the rate of drying of gelatine and starch gums are being studied in a cabinet in which these factors can be closely controlled. Secondly, as corn-starch is used as a moulding medium, an investigation of its equilibrium relative humidity at elevated temperatures is of importance, and an apparatus for carrying this out has been devised and built by the staff of the Association. Other items of research connected with sugar confectionery manufacture are concerned with the properties of glucose used in confectionery (corn syrup), particularly the prevention of foaming on boiling and the tendency for the material to darken on storage.

The programme of research for the meat products group includes biochemical studies on residual tissue respiration and the measurement of oxidation-reduction potential. Colour changes and fading in cooked cured-meats are being studied with the aid of reflectance spectrophotometry. On the technological level, cooking properties of sausages and their colour stability during marketing are being investigated.

The Association's bacteriological laboratory is concerned on one hand with problems connected with bacterial spoilage of food, including the 'blowing' of canned goods, greening in cooked cured-meats and bacterial growth in vacuum-packaged bacon, and on the other hand, with bacterial aspects of the curing and processing of meat. Members are also advised on questions relating to general factory hygiene.

Problems connected with the canning of herrings are being studied by members of the Association's staff at the Torry Research Station, Aberdeen. The work involves chemical studies of herring flesh and the correlation of changes in the constituents of the flesh with flavour changes and with changes in texture which occur during the canning process.

The Association maintains close contact with horticultural stations concerned with the breeding and development of new varieties of soft fruits and helps the industry to assess their suitability for jam manufacture. The tendency for raspberry seeds to go 'blind', that is to say, become less visible, in jam is another problem which has engaged the close attention of the Association.

Much of the work in connexion with pickles and sauces is concerned with microbiological spoilage, and spoilage organisms from a large number of spoiled packs have been isolated and identified. Problems connected with the production of low-acid pickles involve studies of the pasteurization procedures necessary for a product which will combine adequate shelf-life with desirable appearance and eating properties.

In conjunction with the National Institute for Research in Dairying, an instrument for comparing the 'spreadability' of margarines has been developed. This instrument, the '*Fira/Nird*' extruder, has proved to have applications in connexion with other foods and, indeed, in other industries, where the rheological properties of semi-solid materials are important.

The Association maintains an extensive library of books and periodicals. Research reports and other publications are available only to members of the Association, who also receive monthly issues of abstracts from current scientific and technical literature. Some two thousand items are abstracted in a year.

B. R. Knapp

THE STRUCTURE AND CHEMISTRY OF PROTEINS

SYMPOSIUM ON PROTEINS AT PARKVILLE, AUSTRALIA

THE intensification in recent years of research relating to the utilization of the primary products of Australia, wool, meat, wheat and milk, and in medical research, resulted in the organization during September 10–11 of a symposium on "The Structure and Chemistry of Proteins", at the Division of Protein Chemistry of the Commonwealth Scientific and Industrial Research Organization Wool Research Laboratories, Parkville, Victoria.

The meeting was well attended, with eighty-five delegates participating. Several overseas visitors were present, including some who had attended a symposium on "Hæmatin Enzymes" in Canberra, immediately preceding the symposium on proteins.

The topics of the twenty-two papers presented ranged over many of the fields currently being investigated in other parts of the world, a notable exception, however, being studies of amino-acid sequences. This reflects the pre-occupation of Australian workers with the isolation and characterization of protein components from natural products as a necessary first step to a more comprehensive understanding of their structure. Although the complex protein mixtures of these products are the focal point of much of the Australian research, studies involving purified soluble proteins, such as insulin and lysozyme, plasma albumin and other proteins as well as synthetic peptides are, however, also in progress. The rapid advances which are being made in our knowledge of the amino-acid sequence, structure and behaviour of these classical proteins assist in the understanding and interpretation of the chemistry of the more complex biological systems.

The contributions that X-ray, infra-red and electron-microscope investigations have made in the study of the structural organization of keratin were illustrated by the work of R. D. B. Fraser, T. P. MacRae and G. E. Rogers. The application of X-ray crystallography to the study of the three-dimensional structure of a simpler compound, toluene-*p*-sulphonyl-L-prolyl-L-hydroxyproline monohydrate, was described by J. Fridrichsons and A. McL. Mathieson, and this contribution emphasized the stereo-chemical problem encountered with prolyl residues in a polypeptide chain. The properties of protein complexes of the insect cuticle were described by R. H. Hackman and interest was aroused in the nature of their strong bonding to chitin and quinones. The isolation of nucleoproteins and labile plant viruses from leaves and their susceptibility to degradation by salt were discussed by J W Lyttleton

The chemistry of thiols and disulphides is a prominent feature of protein chemistry and was exhaustively discussed S J Leach and J M Swan described the important analytical advances made in this field with the aid of the polarograph and the preparative applications of sulphite in the presence of an oxidizing agent, such as cupric ions The various methods of splitting disulphide bonds and their application in the extraction of soluble proteins from wool were discussed by J M Gillespie, I J O'Donnell and E O P Thompson, and H Lindley reported on the varying reactivity of the disulphide bonds of insulin J M Creeth and D J Winzor were concerned with the specificity of the reaction of iodine with the sulphydryl groups of ovalbumin, while the important role of thiols in disulphide interchange reactions was clearly apparent in the experiments of F J R Hird, R Frater and J R Yates on the nature of cohesive forces in dough Disulphide interchange was also responsible for the inhibition of several —SH enzymes by 'sulphanilamide disulphides' in an investigation reported by E Boeri and L Brighenti

The physico-chemical characterization of proteins isolated from naturally occurring mixtures was covered in a further series of papers The aggregation and disaggregation of soluble proteins and the changes induced during denaturation figured prominently in the discussions of papers presented by J M Creeth and L W Nicol on urease, by B S Harrap, I J O'Donnell and E F Woods on soluble wool proteins and by H A McKenzie on various enzymes and globular proteins The various techniques used to follow conformation changes were critically examined and it became clear that the behaviour of a particular protein in any given system was not necessarily indicative of the behaviour of other proteins in the same system The surface denaturation of proteins was discussed by F MacRitchie and the application of the spread monolayer techniques to a comparison of the surface chemical properties of various cereal proteins was described by N W Tschoegl The preparative applications of electrophoresis were illustrated by the work of J F O'Dea on the isolation of components of serum while P R Carnegie and R L M Synge described the electrophoretic behaviour of cupric complexes of oligopeptides and a possible method for selectively isolating dipeptides from mixtures of peptides

Chromatography as an aid in the purification of proteins was introduced by A G M Marr, who described the fractionation of serum proteins on 'DEAE-cellulose' D H Simmonds has applied this technique very successfully to the water-soluble flour proteins and he also reported amino-acid analyses of the various fractions using ion-exchange chromatography with an automatic recording apparatus capable of handling eight ion-exchange columns eluted simultaneously. The continued interest of chemists in the quantitative analysis of protein constituents was evident in this paper and that of J H Bradbury on an alternative method requiring paper chromatography of dinitrophenyl amino-acids This method was particularly applicable to the estimation of amide groups

G Coleman and W H Elliot described their work on the synthesis of α-amylase by *Bacillus subtilis* and C J Shepherd discussed the effect of inhibitors of protein synthesis in *Aspergillus nidulans*

A feature of the symposium was a lecture by Dr R L M Synge on 'Naturally Occurring Peptides and Their Biological Significance" Although the search for naturally occurring peptides has not been intensive it was apparent from the stimulating survey by Dr Synge that many unusual types of small peptide are already known He went on to stress the necessity for quantitative data in the study of protein synthesis and expressed concern at the lack of experimental documentation for many of the generalizations by biochemists regarding the synthesis of proteins A spirited discussion ensued and was continued in a subsequent session on protein synthesis

Participants in the symposium were fortunate in having a range of papers presented covering most of the rapidly growing areas of investigation in the protein field and it may be hoped that similar conferences will be held in the future

E O P THOMPSON

ELECTRONICS EXHIBITION

THE fourteenth Exhibition of Electronic Devices, organized by the Northern Division of the Institution of Electronics, was held at the Manchester College of Science and Technology during July 9–15 This annual exhibition is now well established and it provides an opportunity for new electronic apparatus to be demonstrated in rather less crowded conditions than obtain at the Physical Society Exhibition held in London during January

A lecture programme was associated with the exhibition and, as is to be expected, a substantial part of this programme was devoted to transistor techniques However, topics of general scientific interest were by no means excluded, and lectures on the argon chromatograph, on photographic densitometry and on the use of X-rays for micro-analysis were well attended

The exhibition was divided into a manufacturers' section and a research section, the research exhibits forming much the smaller part of the whole A relatively small number of research exhibits, especially from universities, has also been evident at the Physical Society Exhibition Although research exhibits are of considerable general interest, and of special interest to those working in related fields, it is probable that for scientific workers as a whole the more important function of an exhibition of this type is to show instruments that are currently available In the manufacturers' section this year's exhibition was notable for the extent of the exhibits of the various electronic agencies These agencies handle the products of a number of manufacturers and they hold stocks of instruments and components In the case of one agency the display occupied a whole room and included examples of the products of some sixty manufacturers

Included in the new equipment on show were examples of 'second generation' oscilloscopes Until very recently, British manufacturers have been unable to offer high-performance oscilloscopes having trace brightness and amplifier band-width suitable for the display of single-pulses having fractional microsecond duration This has meant that workers in such fields as nuclear physics and high-speed computing have either obtained equipment from North America or have constructed their own display systems New types of oscilloscopes are now available from Messrs Cossors, EMI, Marconi Instruments and Solartron The cathode-ray tubes are mostly of the post-deflexion acceleration type and run at voltages of 6–10 kV., amplifier band-widths are 10–20 Mc /s , and the deflexion sensitivity at full gain is about 100 mV per cm This specification is adequate for all but the fastest applications, and for these, two manufacturers are offering oscilloscopes with distributed amplifiers having a band-width from d c to 40 Mc /s Messrs Cossor and Heathkit showed kits of parts that can be assembled to make items of test gear such as valve-voltmeters and simple oscilloscopes The kits normally employ printed circuits, which simplify the wiring, and can be assembled with semi-skilled labour A wide variety of silicon devices are now available, and Messrs Ferranti showed a range of silicon photo-voltaic cells , these have a response time in the microsecond region and have applications in equipments using modulated light The new cells have a high conversion efficiency and in the larger sizes can be used as solar cells to provide electrical energy from sunlight

This annual exhibition continues to be well attended and it provides an opportunity for scientific workers in the north-west of Britain to keep abreast of current electronic equipment and components

V H Attree

UNITED KINGDOM CIVIL SERVICE COMMISSION

THE ninety-third annual report of the Civil Service Commissioners, covering the year April 1, 1958–March 31, 1959, records an increase in the number of candidates successful in open competition from 13,057 to 14,616, but for the administrative class the number of successful candidates decreased from 39 to 37, though well above the 1956–57 figures, and some departments were short of recruits, although the number of unfilled vacancies is not large (Report of Her Majesty's Civil Service Commissioners for the period 1st April, 1958 to 31st March, 1959 Pp 36 (London H M Stationery Office, 1959) 2*s* 6*d* net)

The Commissioners are continuing their efforts to attract a larger number of good candidates from the universities Candidates in the limited competition for the administrative class further decreased in number Recruitment to the senior branch of the foreign service was also disappointing, and the shortage of candidates for the statistician class persists Less than 50 per cent of the declared vacancies as patent examiner have been filled and there was again a shortage of good candidates for scientific officer, engineering and draughtsmen posts, and many vacancies remain unfilled, particularly through a dearth of physicists Grave shortages remain in the telecommunications and other electronic fields , however, there was a small increase in the number of candidates in the senior scientific officer competition and most of the vacancies which had been notified were filled.

Applications in the assistant experimental officer/experimental officer competition remained remarkably steady and generally sufficient candidates were successful to meet departmental needs The supply of biologists again exceeded the limited demand The research fellowship competition continued to attract interest from workers in all fields of research, and thirteen candidates were offered the award There is some evidence that it is becoming harder to attract good applicants for junior fellowships

Results of interviews in Ottawa and Washington in April 1958 to select applications for research fellowships and scientific officer posts were less satisfactory than originally appeared likely, and in the event only one candidate joined the Service as Research Fellow and one as a senior scientific officer, although some well-qualified men appear to have been stimulated to return to Great Britain in the universities or in industry

EUROPEAN NUCLEAR ENERGY RESEARCH

THE seventh annual report of the Netherlands'–Norwegian Joint Establishment for Nuclear Energy Research*, describing the work of the Establishment during the period July 1, 1957–June 30, 1958, mentions that the research reactor, *Jeep*, was in almost continuous operation at 450 kW during the year, with a total release of heat of 105 6 MW days, but that the corrosive effects of the heavy water have grown worse and a minor leakage of heavy water occurred during April The completion of the Halden boiling water reactor, which is an Institutt for Atomenergi project and which is situated inside a rock excavation near the paper pulp factory, Saugbrugsforeningen, will be delayed by about a year because of construction and design problems The reactor tank was completed during the spring of 1958 The necessary amount of heavy water which was purchased from the United States of America is now stored at Halden, and part of the uranium ordered from Great Britain has been delivered An agreement between Norway, Denmark, Sweden, Austria, Great Britain, Switzerland and Euratom, on the joint operation of the reactor, was signed by representatives on June 11, 1958

Because of the higher demand for radioisotopes, and technical improvements in the production system, the number of isotope deliveries from Kjeller to customers outside the Establishment increased by 33 per cent over the previous year The deliveries were mainly to the Scandinavian countries. Detailed information about the type of isotopes produced and their distribution is given in the report. Separate sections deal with the activities of the Chemistry, Metallurgy, Reactor Engineering, Physics and Health Physics Divisions. The chemical analysis of uranium and D_2O is now carried out on a routine basis and the spectrographical methods used for impurity control of medical isotope products and the determination of plutonium have been improved. The main task of the metallurgical group has been the production of UO_2 pellets, and in addition to considerable computational work and experimental tests connected with the Halden boiling water reactor project, the Physics Division has obtained new neutron diffraction data on U_3O_8 and U_4O_9. The Health Physics Division is responsible *inter alia* for the daily radiation monitoring in the laboratories; the radiochemical analysis of biological specimens; and the general medical check-up of personnel. Of the 191 persons controlled by the Division during the year, only one received a radiation dose exceeding 5 rems.

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* Seventh Annual Report, July 1957–June 1958, of the Netherlands'-Norwegian Joint Establishment for Nuclear Energy Research Pp 32 (Kjeller near Lillestrøm Netherlands'-Norwegian Joint Establishment for Nuclear Energy Research, 1959)

The Netherlands–Norwegian Reactor School was officially opened on April 12, and the first nine weeks standard course commenced on April 14 with twenty-eight students: fifteen from Holland, eleven from Norway and two from Switzerland. The construction of the new isotope building was started in January, and of an office building to house the ship propulsion group and the Engineering Division in April. As in former years, the Establishment benefited from the exchange of scientists with similar institutions in other countries. Seven guest scientists worked at the Joint Establishment for Nuclear Energy Research for the whole or part of the period under review. The two sponsoring organizations of the Establishment, the Reactor Centrum Nederland and the Institutt for Atomenergi, took part in international co-operation in the field of atomic energy, in particular, in the European Atomic Energy Society, the Organization for European Economic Co-operation, and the International Atomic Energy Agency. Summaries of the main activities of the two organizations are given in the appendixes to the annual report.

THE FRANKLIN INSTITUTE

THE Board of Managers of the Franklin Institute in presenting their annual report for 1958 (*Journal of the Franklin Institute*, 267, 317; April 1959) express their gratification at the progress during the year in all the Institute's programmes of service to science, but point out that without increased funds the Institute cannot expand and may not be able to maintain its present activities. In addition to the Franklin Institute Laboratories and the Computing Center, both located in Philadelphia, the Institute owns and operates the Bartol Research Foundation in Swathmore, Pennsylvania, and is trustee for the Biochemical Research Foundation in Newark, Delaware. The Institute conducts basic and applied research on a contract basis for government, industry and private concerns, and the Computing Center co-operates with the Laboratories which carry out projects under contract in the fields of engineering and the physical sciences. The Bartol Foundation is concerned with the study of fundamentals in physics, low-energy exploration and cosmic phenomena, and the Biochemical Foundation with cancer research.

It was to be expected that public interest in the activities of the International Geophysical Year, and in rockets, satellites and space travel, would largely colour the work of the Education and other divisions of the Institute during 1958. Of the twenty-one lectures presented at the Institute meetings during the year, eight were on subjects related to the space age; the exhibit, "Progress of Time", contributed to the Institute's Science Museum by the Hamilton Watch Co., included the Mars Space Clock, and other loan exhibits showed the successful launching of the *Explorer* rocket, the *Vanguard* satellite, and the *Pioneer* lunar probe; new presentations in the Planetarium were "The American Satellite" and "Astronomy in History", and the staff of the Planetarium were responsible for the operation of the Institute's Moonwatch Station; and the series of ten semi-technical lectures on astronautics sponsored by the Astronomy Department were published in December as Monograph No. 6 entitled "Ten Steps into Space".

The Library of the Institute, which began as a small collection in 1824, now comprises 162,054 volumes, of which 3,054 were acquired during 1958—986 by purchase, 544 by gift and 1,524 by binding. New accessions included eighteen Russian periodicals, four in translated English editions, and a remarkable set of the owners' file copies of records and correspondence of the Penang Sugar Estates Co. (British Malaya), comprising twenty-three handwritten volumes of the work of the Company during 1876–97. A symposium on "Thermoelectric Effects" was held on September 8, primarily for research workers in this specialized field, and an all-day symposium on "Odour" on October 21 during the "Cleaner Air Week" in Philadelphia. Three new titles were added to the series of monographs published under the auspices of the *Journal*: "Particulate Emission", "The Airways Modernization Board—Its Mission and Methods" and "Ten Steps into Space" mentioned above.

Details are given in the illustrated report of the long-range research programmes and new developments of the separate research organizations. These include air-pollution research; thermoelectricity and semiconductors; electron microscope studies of dislocations in metals and zone refining of reactive metals; the physics of polymers; and flow loops in nuclear engineering. A novel etching technique has been developed for studying dislocation loops generated in metals under stress and their motion and growth in zinc have been filmed (*Journal of the Franklin Institute*, 267, 335; 1959). A simple sonic-vibration method for the early detection of glaucoma has been demonstrated and an all-transistorized sensitive cane for use by the blind has been successfully tested. The report concludes with brief details of the finances of the Institute, the membership and staff.

ECONOMIC DEVELOPMENTS IN THE MIDDLE EAST

IN a report dealing with developments for the year 1957–58, published by the United Nations as a supplement to the world economic survey of 1958, there is included a useful survey of agricultural production and development, industry, petroleum production, and foreign trade in the several main countries included in this politically highly sensitive world region (Iran, Iraq, Israel, Jordan, Lebanon, Saudi Arabia, Sudan and Turkey) About one half of the text deals with factual summaries, and about one half gives statistical tables (Economic Developments in the Middle East, 1957–1958 (Supplement to World Economic Survey, 1958) Pp viii+104 (New York United Nations , London H M Stationery Office, 1959) 1 25 dollars , 9*s* , 5 Swiss francs)

The information given regarding the key product, oil, has special interest The rapid recovery and expansion of this industry during 1957 (after the decline in production as a result of the Suez crisis) is remarkable In 1957 there was an increase over 1956 of only 3 7 per cent, but this advanced by a further increase of 20 7 per cent in 1958 The total production of the Middle East as a share in world production rose to 23 6 per cent in 1958 as compared with 20 per cent in 1957 The main contributors to the large rise in oil production were Iran and Kuwait, but though producing relatively small quantities, other countries have been expanding their output at a high rate, and a new entrant was Syria where, in the north-east of the country, a field was discovered in 1958 estimated to have an output capacity of about 2 million tons Agricultural production in the same year shows continued expansion at the rate of about 3 per cent per annum, both in food production and in the output of industrial cash crops on which the several countries depend as a major source of foreign exchange It is significant that the rate of growth in both exceeded the growth of population A continued shift in the pattern of production towards industrial cash crops and greater use of fertilizers and agricultural machinery helped to maintain the rate of agricultural output, but the uncertainty of climatic conditions caused wide fluctuations

Apart from the physical difficulties affecting production within the region, two comprehensive programmes of agrarian reform were started in the Syrian region and in Iraq late in 1958, and the social change and redistribution of income that these are likely to produce will very probably have a strong impact on the shape of future economic development From these economic changes within, there emerges a picture of foreign trade and payments showing much variation, and with interesting evidence of change in operation leading to shifts in the geographical direction of trade, particularly of the cotton exporting countries , thus the United Arab Republic and Sudan moved away from Western Europe and the United States toward the U S S R , Eastern Europe and the Far East Iran, Jordan, Turkey and Israel, on the other hand, maintained their high share of trade with the United States and Western Europe, although an increasing proportion of the exports of Israel and Turkey went to eastern European countries in 1957 and 1958 Oil exports show a significant increase in their share to Asia and the Far East, though the dominant traditional markets in Western Europe are maintained ALICE GARNETT

THE NATURE OF POLISHED METAL SURFACES

HOOKE, Newton and Herschel all held that the asperities in a roughly ground surface are cut away during polishing, leaving a series of fine grooves , the finer the polish the finer these grooves or 'scratches'. Rayleigh agreed that the asperities are worn down but thought that the material is removed in an almost molecular fashion In 1921 Beilby advanced the radical view that, instead of the asperities being worn away, the depressions in the surface are filled in by material which is smeared across the surface, covering it with a layer which he thought was glass-like or amorphous in character This has come to be known as the 'Beilby layer' The idea of the layer being truly amorphous has been modified slightly in more recent times, but the basic concept of a layer which is physically distinct from the substrate and which has lost its obvious crystalline properties is still retained

Beilby did not propose any specific smearing mechanism, although he inferred that surface tension forces were responsible A most plausible mechanism was afterwards advanced by Bowden and Hughes which was based on observations that very high local temperatures can be attained when two solids rub past one another They suggested that asperities in the surface are melted when abrasive particles rub across them, the liquid so formed depositing in and filling adjoining depressions It was further proposed that, due to very rapid chilling, this molten material solidifies in an amorphous-like condition

A paper by L E Samuels reviews work carried out at the New South Wales Branch of Defence Standards Laboratories which strongly supports the earlier view that polishing is essentially a fine cutting process, and is believed to establish with reasonable certainty that the Beilby layer does not exist

The new theory is that metallographic polishing occurs primarily by cutting, the individual abrasive particles acting in a similar manner to a planing tool Material is removed and scratches are produced , the better the polish the finer the scratches The surface is crystalline but deformed, the magnitude of the deformation decreasing with increasing fineness of polish to a surprisingly low level in the case of the finest polishes Moreover, the deformation decreases rapidly with depth so that comparatively perfect material is exposed by a very light etch (*Austral J Sci* , 21, 6 , 1959)

EEL MIGRATION

It seems probable that many of the difficulties that have undermined Dr Tucker's belief[1] in the ability of European eels to return to the Sargasso Sea would have disappeared if he had compared the European eel with the Atlantic salmon, the return of which to spawn after a migration of comparable difficulty is more readily demonstrable

Salmon, both Atlantic and Pacific, migrate to feed in the sea · here they may stay for one and a half to four or more years This active feeding period is followed by a spawning migration during most of which the animal does not feed Fasting begins as the salmon nears fresh-water, the subsequent migrations upstream, often carried out under difficult physical conditions, are very fatiguing and call for a considerable expenditure of energy Yet, after a migratory fast lasting up to a year, millions of salmon survive to partake in most energetic spawning activities In fact, about 5 per cent return to spawn again, and a small proportion may spawn three times

Eels spend most of their lives feeding in fresh-water This feeding period of from six to twenty-five years duration is as clearly preliminary to spawning migration as are the years spent by the salmon in the sea I do not agree with Dr Tucker that European silver eels are starving and debilitated the many thousands that I have handled have been vigorous, extremely energetic and in good condition It is of interest that eel-dealers store living eels for long periods, yet these eels are in the end still fat enough to be sold as highly nutritious food

On their 3,500-mile spawning journey, eels have to contend only with slow-moving ocean currents, not to be compared with the fast-flowing streams encountered by salmon If eels travel at a modest 40 miles a day, the journey need take only thirteen weeks—not a long fast compared with that of many salmon

Dr Tucker claims that American eels, because of their larger size and apparently juvenile sex condition, are better suited than European eels for their spawning migration But size is not a criterion of condition, salmon, ranging from 3½ lb to more than 60 lb, complete their spawning migration successfully; many reach the rivers of Britain in an advanced stage of sexual maturity, fast, and survive to spawn Recent examinations of the state of the gonads in large samples of eels have convinced me that the European silver eel is not "already well advanced towards being a reproductive oceanic fish" The gonads of silver eels are not in an advanced stage of development Many silver eels migrate when their gonads are scarcely more advanced than those of yellow eels In fact, the gonads of the silver eels are in about the same developmental stage as those of female salmon smolts and unspawned male smolts

One of the most strongly emphasized points in Dr Tucker's argument is that European silver eels are rarely caught at sea But neither apparently are American eels Nor is it surprising that eels at sea are elusive They do not feed and so cannot be caught on long-lines, nor are they likely to stay captive in any normal deep-sea trawl It is no cause for astonishment that eels are not caught in the Straits of Gibraltar, for no commercial fishing gear in use there can be expected to catch eels Salmon are rarely caught off shore, and salmon should be much more catchable, for they feed in the sea, they stay there much longer and they are not so shaped as to make escape from nets easy Yet countless millions reach their spawning grounds yearly, though the number caught in the open sea is very small

Finally, Dr Tucker's hypothesis requires that a large proportion of the American eel population is 'lost' yearly as a reproductive potential, since American eels which spawn in the wrong place produce progeny which become European eels and never succeed in spawning If this were a true account, there would be intense selection in favour of eels which found the 'right' spawning ground It would be very surprising if natural selection on this large scale had failed to eliminate the European eel in a few generations

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I must emphasize at the outset that Dr Jones's communication, even if it were acceptable in its entirety, contains nothing relevant to the fundamental problem of eel navigation and nothing which has any bearing upon my hypothesis that the two Atlantic *Anguilla* phenotypes may be environmentally differentiated and distributed without genetic intervention For the rest, the difficulties which led to a heavily documented paper[1] are not likely to be dispelled by criticism which ignores not only literature already cited, some of it on two occasions[1,2], but also that relevant to its own substantiation Moreover, a recent independent review[3] has made such a comparison as Dr Jones demands, and without detriment to the new theory of eel migration

Both the salmon and the eel undergo migrations which raise problems of navigation, physical effort, condition and osmo-regulation Thereafter the comparison breaks down to such an extent that knowledge of one casts little light on the ways of the other The eel is catadromous; the salmon anadromous The first migration of the eel is as a larva passively transported in the surface layers; its second as a starving adult travelling in the deeper layers and probably by a different return route Both of the migrations of the salmon are accomplished as an adult fish, travelling in substantially the same water-masses along the same routes and actively feeding until the final return to fresh-water Eels are in peak condition shortly before the commencement of their final journey; salmon shortly before the end of it

The European eel is, in Dr Jones's view, an ocean traveller, accomplishing a long journey of at least 3,500 miles for the south-west European stocks and at most 5,000–6,000 miles for the White and Black Sea stocks The longest recorded journey for an Atlantic salmon is 1,730 miles in 328 days[4], characteristically, its migrations are much shorter—a few hundred miles along the coast or to and from feeding-grounds off the shelf—and fairly easily explained by internal changes in the osmo-regulatory mechanism which prompt it to seek salt or fresh water and by a proved propensity to wander along the coast until it smells the outfall of its native stream. However arduous the last stage of the journey of the salmon up-river, it can and does alternate activity and rest and make use of slack water and pools for the latter purpose; for the eel in an opposing ocean current no such respite is possible without losing ground.

Segregation of breeding stocks of salmon provides excellent opportunities for adaptive variation and variation of inherited behaviour-patterns through genetic isolation; in the eel nothing of the kind is possible.

Given this summary of the habits of the two fishes, which further have very different patterns of locomotion and are widely unrelated, I see very little ground for generalization from one to the other; the analogy is rejected with good reason, but Dr. Jones should not assume that it was ignored.

Salmon survival for subsequent spawnings is due in part to the fact that degenerative changes in the gut are confined to the mucosa, which is renewed in kelts that recover[5]; in the eel the changes are profound and lead ultimately to complete destruction of the gut[2,6]. The personal findings of Dr. Jones, like those of Prof. D'Ancona previously dealt with[2], do not affect the evidence that the gut of the European eel is self-destroyed before the fish is more than a few hundred miles offshore.

Here a new point may be introduced. Experimental work on the eel has shown that in the sea it contrives to maintain effectively the internal environment of the freshwater fish. It does this by swallowing sea water, absorbing water and salts through the intestine, excreting an isotonic urine and discharging surplus chlorides through the secretory cells on the gills[7]. In European eels, once degeneration of the gut has proceeded merely far enough to impair the absorptive function, this mechanism can no longer operate; osmo-regulation must then depend wholly upon the relative impermeability of the body mucus and upon compensating liberation of water through breakdown of stored lipo-proteins. Failure of the whole apparatus would lead to rapid exsiccation and death. Experimentally induced failure, by preventing eels from swallowing sea water, does in fact produce an 11–14 per cent loss in weight and death within 3–4 days[7]. This situation, even more than the likely inadequacy of the food reserves to provide for locomotion, physiological work (for example, in chloride secretion) and gonad maturation, could account for the failure even of Mediterranean eels to reach apparently suitable breeding-grounds in that sea (*post*).

I am not subdued by Dr. Jones's experience with thousands of eels. The great curse of the voluminous work upon eels, upon the Salmonidae and upon sundry other animals, has been that too much of it has been mechanical and repetitive, replete with experiments unintelligently planned and mountains of data inadequately pondered, parochial alike in the range of its geographical experience and in its isolation from relevant literature from alien countries and related disciplines.

The physiology of the eel is not "clearly preliminary to spawning migration"; it could be, and I think is, atavistic and doomed to fruitless failure. We have no right to assume climax as normality in any incomplete behaviour-pattern or physiological process when climax has never been observed and no unequivocal circumstantial evidence of climax is available.

I agree that a 'stored' silver eel may well retain its condition like any other relatively quiescent animal; migrating eels, however, lose up to 20 per cent of their weight before they leave the Baltic[8] (reserve fat amounts to about 25 per cent) and this over periods greatly in excess of that shown to be necessary for the initial osmotic adjustment[7]. Either the food reserves are being rapidly used up, or there is a loss of water showing that the osmo-regulatory mechanism is already breaking down under the quite low salinities of the Baltic.

Dr. Jones suggests a hypothetical "modest 40 miles a day" over thirteen weeks for the eel migration. Norwegian work[9] summarized by Menzies[10] has shown that, of 598 long-distance journeys by marked and recovered salmon, 569 were accomplished at 5–25 miles a day and only twenty-nine at higher speeds up to 62 miles a day. Speeds for Baltic eels marked on a comparable scale[8] (the work was cited previously[1]) are in general between 5 and 10 miles a day; the record is 32.5 miles a day sustained over a mere two days.

Comparative data for condition of American and European eels are hard to come by. Vladykov[11] gives 411 gm. for the mean weight of Quebec bronze eels of 61 cm., compared with Frost's 425 and 414 gm. for 61 cm.[12] Windermere yellow and silver eels, respectively. The superficial agreement does not allow for the fact that the American eels cited are at an earlier and probably much younger stage, nor deny that the average weight of migrating American females is four times greater than that of the European, that their maximum sizes and weights are greater and their potential journey much shorter. I do not think we can avoid the conclusion that the American eels are better prepared. Dr. Jones's citation of the range of weights of salmon grilse is meaningless without an indication of the success-rates at different sizes and of the conditions overcome. Such data as are available for the migration speeds of the outward-bound salmon smolt[13] show that these are much slower than those of the larger returning grilse. Further, maximum velocity in fishes is a function of length and frequency of tail-beat; though the latter does fall with increasing size, larger individuals are faster swimmers[14].

My paper[1] mentioned merely "perceptible enlargement of the gonads", a statement in agreement with Dr. Jones's findings. It then proceeded clearly to specify those characters of migration livery and bathypelagic adaptation in which, by comparison with the American eel, the European may be regarded as advanced.

A surprising variety of fishes, including other Apodes, have been taken in deep-sea trawls by scientific expeditions; I have before me 29 *Synaphobranchus* from a single haul of an Agassiz trawl at 1,300 metres. There are at least 108 cases of records, with Scottish interest alone, of salmon taken at sea, 82 by trawls and various nets[15]. Salmon are surely less numerous than eels; being capable of a maximum velocity of 10 m.p.h. for short periods[16], compared with the eel's peak 2.6 m.p.h.[17], they should have greater chances of avoiding nets and not less. The infrequency of capture of eels in European seas remains significant. Non-capture of American eels is agreed; there is, however, no convergence of essential migration routes and intensive trawling comparable to that of north-west Europe. I did not write of "commercial fishing gear" in the Strait of Gibraltar but of an "intensive study"; still more explicitly, scientific investigations by Danish, French and Monagasque expeditions

Evolution by natural selection of a population which chose the 'right' spawning-ground would be conceivable enough in the case of, say, salmon in polluted and unpolluted tributaries of the Welsh Dee The case of the eel is not so simple The Atlantic *Anguilla* forms are believed to be environmentally differentiated by differences in the temperature stratification[1] and are certainly differently distributed by the various movements of the surface layers of the Sargasso between lat 20° and 30° N In the underlying deep waters in which the eels breed, the temperature and salinity conditions at a given depth are relatively uniform over a wide area , it is therefore unlikely that any sensory discrimination could pick a 'right' spawning-ground directly related to a 'right' surfacing-area Selection in relation to travelling and ripening times could not have any genetic effect owing to the failure of the current-system to return the larvæ precisely to the parental starting points along the American coast While the new hypothesis may seem more spectacular, it is statistically no more remarkable than the normally high infantile mortality-rate accepted in marine animals , the survival-rate is still sufficient to maintain the population Parallel cases of expatriated populations failing to breed are the British *Octopus vulgaris*[18], the Norwegian *Palinurus elephas*[19] and the Lagos *Branchiostoma nigeriense*[20], all of which are maintained by immigrations of larvæ bred elsewhere and so represent similar cases of wasted reproductive potential

There is likewise no ground for belief in selection producing genetic restriction of the eco-phenotypic variability potential of the Atlantic *Anguilla*, that is, eliminating the phenotypes with 110–119 vertebræ as such, as opposed merely to those going to Europe

Some further evidence in favour of the new hypothesis is now briefly noted

Possible parallel cases Bruun[21] has commented on the hitherto unexplained coincidence that, of four pairs of Atlantic apodal 'species', having distributions roughly similar to those of the two types of *Anguilla* larvæ and, moreover, larvæ which can be taken "at the same place and same depth within a certain area of the Sargasso Sea", the American 'species' of each pair has the lower number of vertebræ (Table 1) This situation may well be due to a common eco-phenotypy rather than to coincident genetic effects

Table 1 NUMBERS OF VERTEBRÆ OR MYOMERES IN SOME NORTH ATLANTIC EELS, MAINLY AFTER BRUUN (REF 21)

	East Atlantic	West Atlantic
Anguilla anguilla	110–119	—
Anguilla rostrata	—	103–111
Conger conger	154–163	—
Conger oceanicus	—	140–149
Synaphobranchus kaupi	143–154	—
Synaphobranchus infernalis	—	131–140
Leptocephalus euryurus	111–119	—
Leptocephalus similis	—	104–113

Likewise, Tambs-Lyche[22], supporting the new hypothesis, has suggested that there is a similar pseudo-speciation in the Atlantic Paralepid fishes (order Iniomi)

Extended pelagic phases 'European' eel larvæ grow to a greater length and unmetamorphosed age than the 'American' and are, on the new hypothesis, regarded as an extended pelagic phase of one species Parallel cases of facultative prolongation of larval or juvenile life in marine animals under conditions unfavourable to metamorphosis occur in the surgeon-fish *Acanthurus hepatus*[23], the frogfishes *Antennarius* spp [24], the *Macrotritopus* larvæ of the benthic octopus *Scaeurgus unicirrhus*[25], and in numerous Decapod Crustacea[26]

Selection of breeding-grounds by Anguilla *and* Conger On the old hypothesis, *Anguilla anguilla* and *A rostrata* were separate species with distinct breeding-grounds in the Sargasso Sea The American *A rostrata* and *Conger oceanicus* shared a common breeding-ground The European *C conger* shared the only breeding-ground of *A anguilla*, but also used other breeding-grounds between Gibraltar and the Azores and inside the Mediterranean[27]

I have already noted the fact that *A anguilla* does not breed in apparently suitable areas much nearer Europe than the Sargasso[1] The paradox raised on hydrological considerations is now reinforced by *Conger conger* acting as a biological indicator We may conclude that the 'European' eel is not breeding in the Sargasso, any more than it is in the Mediterranean or Eastern Atlantic

Location of the Anguilla rostrata *breeding-ground* I previously suggested that the *A rostrata* breeding-ground had been placed too far west[1] In support of this contention, be it noted that, until 1920, catches of *A rostrata* larvæ from all sources totalled only 34 specimens[28] In 1920 the *Dana* took a further 1,000 specimens ; because, however, her track out of Porto Rico towards New York[29] followed the north-east boundary of the 15 mm *A rostrata* contour, it follows that data for and within that contour remain thoroughly inadequate The probable breeding-ground between *c* lat 20–22° N, long 50–60° W has not been investigated at the proper season Material of the other American Apodes cited above is likewise scanty by comparison with the European[21,27]

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MECHANISM OF ANIMAL JOINTS

Sponge-hydrostatic and Weeping Bearings

ANIMAL joints are very efficient pivots Charnley[1] gives 0 01–0 02 as the friction coefficient of a human ankle joint and shows that this low friction does not result from hydrodynamic lubrication He points out that ordinary boundary (thin-film) lubrication would produce five or ten times the observed friction and suggests that Nature may have discovered, in its combination of cartilage and synovial fluid, a system which is very slippery even under conditions of boundary lubrication The purpose of this communication is to propose an alternative system, which is, in fact, an example of a new and interesting class of bearings The principle is illustrated by the experiments to be described

A piece of closed-cell sponge rubber (cell size 0 7 mm and less) had one of its impervious cover sheets cut off to expose the cells This surface, lubricated with soapy water, was placed against a glass plate with a loading of about 40 lb /in ^{2} The friction coefficient was then measured as a function of the time for which the load had been applied (Fig 1, curve *a*). The friction coefficient is extremely low, but rises in the course of an hour or so If the sponge is separated from the glass for a few moments and then replaced, the friction falls to its initial low value This is consistent with the idea that most of the load is supported in a frictionless manner by the little volumes of liquid trapped in the pores of the sponge It is, in fact, a 'hydrostatic' bearing The sponge material itself, being surrounded by liquid, is pressed against the glass only by its own stiffness This is small enough to produce very little friction but still large enough to seal the cells (hydrostatic lubrication is not new, but previous arrangements have depended upon mechanical design to contain the lubricant and upon external pumps to pressurize it) The liquid pressure was measured and found to be about that required to support the load Observation, through the glass, of the working face of the sponge clearly showed the water-filled pores The movements of a particular volume of water could be traced by using dye Substantial outward seepage of the water had occurred in an hour, which seems to explain the observed increase in friction with time For purposes of comparison a sample of sponge rubber with open cells, but otherwise of about the same texture, was used This should allow much greater seepage of fluid Note (Fig 1, curve *b*) the tremendous increase in the rise of friction Lastly, to check the technique of measuring friction, a piece of closed cell sponge was tested with its cover sheets intact (Fig 1, curve *c*) This shows the high value expected for plain rubber once the wring-out of lubricant established boundary lubrication conditions

A difficulty arises if one attempts to explain animal joint lubrication by this principle The animal joint appears to involve two similar surfaces rather than a hard, impermeable surface running against the equivalent of a sponge Two sponges do not run very well against each other Suppose, however, that the sponge has a smooth, porous surface layer Because of the porosity, this layer is surrounded with liquid, and so is not pressed hard against its mating surface At the same time it is smooth enough not to become entangled with the similar layer on the other surface of the bearing The effect of porosity was demonstrated with closed-cell sponge One of the cover sheets, and the underlying cells, was perforated with a sewing needle This porous surface was run against glass using soapy water lubrication and showed much less friction (Fig 1, curve *d*) than the unperforated cover sheet (Fig 1, curve *c*)

A true animal joint model with two similar surfaces was much more difficult to imitate It was hard to find a porous material which did not have an enormous friction coefficient when rubbed against itself I found the best material to be sausage casing made from sheep intestine, lubricated with soapy water Imitation cartilage was made by stretching this over the cut-open face of closed-cell sponge Running two 'cartilages' against each other gave the result shown in Fig 2, curve *a*, where the friction coefficient starts low and rises as seepage occurs To check that trapped water is necessary, open-cell sponge was substituted for closed-cell sponge in the previous arrangement (Fig 2, curve *b*) Easy escape of the water quickly raises the friction Finally, the sponges were replaced by impervious 'Neoprene' sheets Fig 2, curve *c*, suggests that hydrostatic lubrication is occurring This is presumably because the sausage casing itself contains considerable free water

It should be pointed out that although the reasoning in this communication arrives at the permeable-surface-sponge-backed bearing as a modification of the sponge-type hydrostatic bearing, it could equally well be thought of as a bearing with a thick film of lubricant, where 'weeping' through the porous wall supplies enough liquid to maintain the film

Weeping bearings give friction coefficients as low as those in animal joints They can be made by

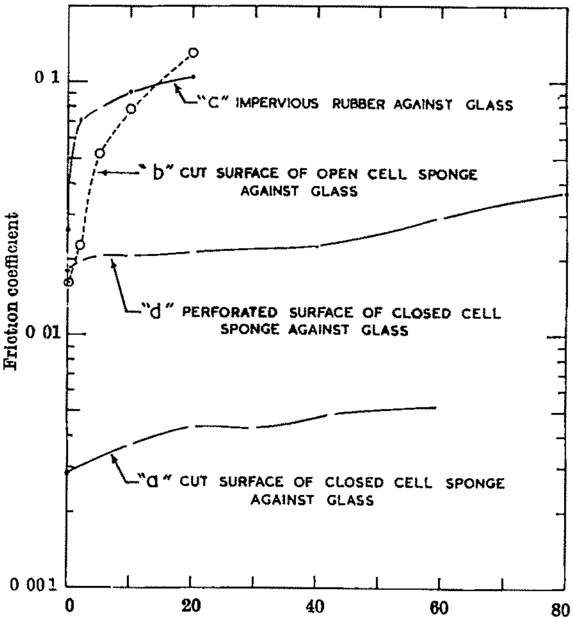

Fig 1 Friction of various surfaces against glass when lubricated with soapy water

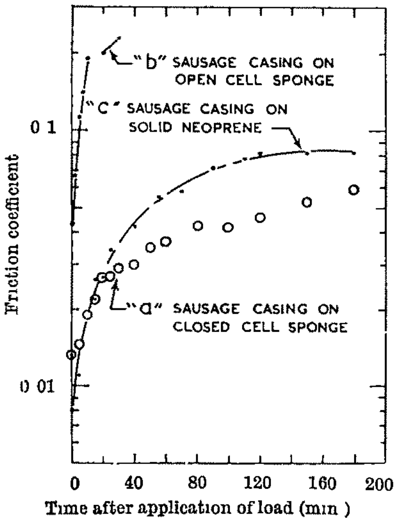

Fig 2. Friction of various types of surface against themselves when lubricated with soapy water

using surfaces and lubricants which do not give exceptionally low friction under boundary lubrication conditions (The animal-derived sausage casing used showed entirely ordinary friction coefficients once the excess lubricant had been wrung out) Animals joints could operate in this way In the following communication evidence is presented to suggest that they do

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Experimental Evidence for Weeping Lubrication in Mammalian Joints

From existing reports[1] it is clear that the structure and mechanical properties of articular cartilage are just what are required for weeping lubrication to be possible Its outer surface is formed by a narrow layer of flattened cartilage cells and below this is a relatively acellular zone extending for some hundreds of microns down to the calcified tissue What cells there are in this zone are arranged in columns, well separated by wide areas of intercellular matrix, which probably has a structure orientated normal to the surface layer Articular cartilage is easily deformed by pressure but is very resilient, being almost perfectly elastic to intermittent pressures , and it has been suggested that this elasticity is due to exudation and re-absorption of fluid[2] Thus articular cartilage appears to resemble a rather stiff sponge, with an internal structure which would permit easy expression of fluid up to a smooth, presumably porous, outer surface

Structural evidence alone is inadequate, so a few simple experiments have been made on articular surfaces from freshly opened joints of a number of mammals Thin shavings were analysed for sodium and potassium with a flame photometer. The ratio of sodium to potassium found was of the order of 12–15 on a molar basis , so articular cartilage must contain a very high proportion of extracellular fluid, as suggested by histological preparations Exudation of only a small fraction of this total extracellular fluid would provide an adequate lubricating film That the superficial layer of flattened cartilage cells is freely permeable to small molecules is easily shown by dropping aqueous solutions of dyes on to a freshly exposed surface Dyes such as eosin, for example, rapidly penetrate to a depth of at least a hundred microns Furthermore, if excess dye is washed off, some of that which has penetrated can be re-extracted by pressing filter paper firmly against the articular surface The pore size in this superficial layer is probably quite small, since a graphite suspension with a particle size of rather less than 1μ did not appear to penetrate

If an articular surface which has been well dried with filter paper is placed against a glass slide and the point of contact examined through the glass with a microscope, fluid can be seen to exude as pressure is applied The amount of fluid exuded was estimated by placing a small piece of filter paper of known area on an articular surface and applying pressure for a brief period of time (less than a second) The sodium content of the filter paper was then measured with a flame photometer and the volume of exuded fluid calculated on the assumption that it had the same sodium content as extracellular fluid Both dry and moist filter paper were used with substantially similar results When the pressure applied was only sufficient to bring the filter paper into intimate contact with the cartilage, the amount of sodium collected was insignificant As the pressure was raised, however, the amount collected increased, and for pressures in the range to be expected in normal operation of the joint the volume of fluid exuded was calculated to be sufficient to form a layer 15–35μ thick over the area of contact Between two articulating surfaces twice as much fluid should be available, which ought to be sufficient for adequate lubrication by the mechanism suggested in the previous communication.

Weeping lubrication could equally well occur where tendons change direction (for example, the patella at the knee joint), for the cartilage surface concerned appears to have the same properties as that in the joint proper

One possible disadvantage of weeping lubrication is the occurrence of a slow outward seepage of fluid from between the apposed surfaces, which might eventually come into contact Joints seldom remain in a fixed position for very long when they are bearing a load Animals which sleep standing up, for example horses, are said always to change their position at least every half an hour, and examples are quoted in the previous communication of model bearings which retain their low friction for at least this length of time The rate of seepage would be markedly affected by the microstructure of the articular surface, but unfortunately little is known about this

It has not proved possible to devise a crucial experiment which would prove conclusively whether or not 'weeping' lubrication is an important factor in reducing joint friction Nevertheless, the evidence put forward here strongly suggests that all the necessary conditions are present , so it would be strange indeed if this type of lubrication did not in fact occur

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EXPERIMENTS ON THE DEVELOPMENT OF ISOLATED BLASTOMERES OF MOUSE EGGS

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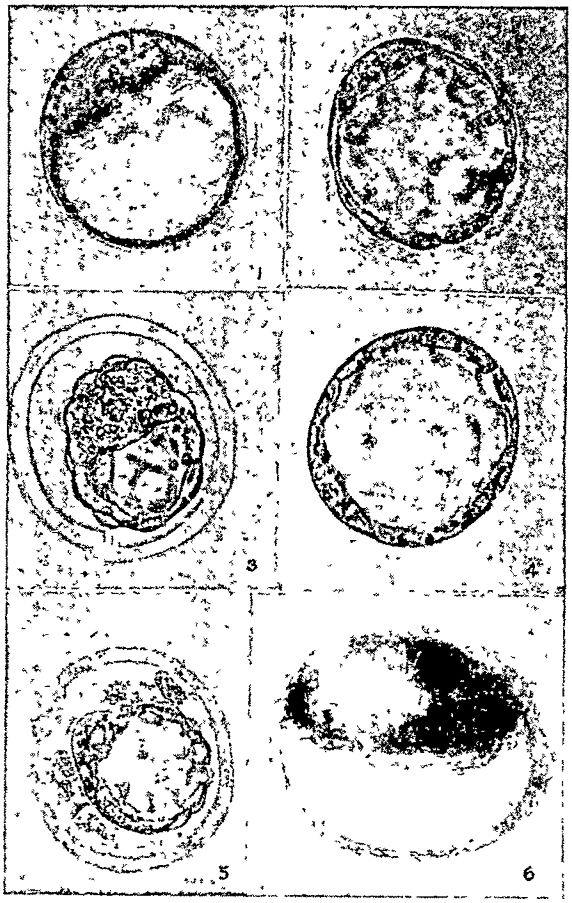
EXPERIMENTAL research on the developmental potency of blastomeres of mammalian eggs has not, so far, advanced beyond the preliminary period Nicholas and Hall[1] found that development of embryos starts to take place from both separated blastomeres of a 2-cell rat egg These embryos, although completely normal in structure, did not, however, advance beyond the egg cylinder stage, and underwent resorption before the tenth day of development Seidel[2] succeeded in obtaining two young rabbits which had developed from 2-cell eggs in which one of the blastomeres had been destroyed by piercing it with a glass needle , he did not carry out any checks of the development during pregnancy. Apart from a short note by Pincus[3], there are no reports in the literature on the development of isolated blastomeres before implantation

The investigations described below were carried out on mouse eggs, and were aimed at . (1) tracing the entire embryonic development of 'half'-embryos , and, on this basis, (2) defining the regulation capacities of 'half'-blastomeres and of the factors on which they are dependent Special attention was devoted to the structure of the blastocysts in order to ascertain to what extent the inner cell mass and trophoblast participate in their total mass Experiments were also carried out on a smaller scale on the development of 4-cell eggs of which one or three blastomeres had been destroyed

The blastomeres were destroyed under a dissecting microscope by piercing them through the zona pellucida with a glass needle fixed to a micromanipulator similar to that described by Goldacre[4] During this operation the eggs were drawn to and held against the mouth of a micro-pipette, with an outer diameter of about 40μ, the suction power of which was regulated by means of the rubber bulb attached to it All manipulations were carried out in mouse serum diluted 1 1 with normal saline Directly, or a few minutes after piercing the blastomere, it disintegrated totally or partially Using the technique previously described[5], the eggs were then transferred to the oviducts of the recipients, which had been mated the previous night with vasectomized males Animals with differing pigmentation were used as donors and recipients for the experiments, which were aimed at obtaining embryos from the second half of pregnancy or young

Development before implantation A total of about 100 'half'- and 'three-quarter'-cleaving eggs and blastocysts was obtained The volume of most 'half'- and 'three-quarter'-blastocysts is similar or only slightly smaller than that of normal blastocysts (compare Fig 1 with Figs 2 and 4) Some 'half'-blastocysts were, however, encountered lying loosely within the zona pellucida (Fig 3) The volume of the inner cell mass of 'half'-blastocysts, treated as the elliptical cap, is subject to wide variations, but in no case does it attain the smallest value found in normal blastocysts Its average size, as a percentage of the size of inner cell mass of normal 3½-day blastocysts, is 44 5 The volume of the inner cell mass of 'three-quarter'-blastocysts varies within the wide limits of variability observed for 'half'- and normal blastocysts

After carrying out observations in the living state, the blastocysts were then fixed and mounted *in toto* in order to determine the number of cells composing the inner cell mass and trophoblast The average total number of cells of 'half'- and 'three-quarter'-



(1) 3½-day normal blastocyst (× 300) (2) 'Half'-blastocyst Size equal to normal, small inner cell mass (× 300) (3) 'Half'-blastocyst lying loosely within zona pellucida (× 300) (4) 'Half'-blastocyst without differentiated inner cell mass (× 300) (5) 'Quarter'-blastocyst composed of about twenty cells Most of them form trophoblast (× 300) (6) 'Quarter'-blastocyst composed of only eight cells, six in inner cell mass and two in trophoblast Stained with hæmatoxylin, mounted *in toto* (× 750)

blastocysts was respectively 68 5 and 68 3, and number of cells of the inner cell mass is 33 0 and 58 4, again as a percentage of the number in normal 3½-day blastocysts

The numerical ratio between the cells of the inner cell mass and trophoblast varies considerably in the various 'half'- and 'three-quarter'-blastocysts Among the developing eggs there were several 'half'-blastocysts without a differentiated inner cell mass (Fig 4), and several morulas in which, despite the aggregation of a large number of cells, the differentiation of the trophoblast had not taken place

It would seem that my results are connected in a logical manner with those of cytochemical investigations by Dalcq and his co-workers on the development of the eggs of rodents[6–9] The following facts established by these authors are the most important for the interpretation of present observations · (1) the oocyte and fertilized undivided egg have a bilateral symmetry resulting from the disposition of the two cytoplasmic zones, which differ from each other cytochemically The cytoplasm of the dorsal and ventral zones passes respectively to the cells of the inner cell mass and the trophoblast (2) The plane of the first cleavage division has no established relation to the plane of symmetry of the egg

The variations in the numerical ratio between cells of the inner cell mass and the trophoblast in 'half'-blastocysts, and the variations in the volume of the inner cell mass itself, are presumably the result of variable distribution of the cytoplasm of these zones to each of the 'half'-blastomeres According to Jones-Seaton[7], there is a tendency in the ova of rats to symmetrical or oblique placing of the plane of the first division This would explain the fact that the majority of 'half'-blastocysts consist of both the inner cell mass and trophoblast, and that forms having only one of these elements are relatively rarely encountered As a result of the second cleavage division, the difference between the blastomeres, as regards the character of the cytoplasm forming them, becomes even more emphasized[7,8] The destruction of a blastomere chiefly composed of cytoplasm intended for the formation of either the inner cell mass or the trophoblast would result in wide variations in the structure of 'three-quarter'-blastocysts

A single 'quarter'-blastomere is also capable, at least in certain cases, of forming a blastocyst composed of the inner cell mass and trophoblast (Figs 5 and 6) The degree of participation of these elements in the structure of these two 'quarter'-blastocysts is, however, quite different

Since the degree of formation of the inner cell mass and trophoblast in 'half-' and 'quarter'-blastocysts is not identical with that in normal blastocysts, the regulating capacities of 'half'- and 'quarter'-blastomeres cannot be considered complete The fate of the cells which have arisen from a given blastomere must to a large extent be determined by the character of the cytoplasm forming that blastomere The fundamental factor determining the developmental potency of 'half'-blastomeres in each case would thus be the position of the first cleavage division in relation to the plane of symmetry The first two 'sister' blastomeres can, but need not necessarily, be characterized by identical capacities for further development

Development after implantation Of 175 transplanted 'half'-blastomeres, 54, or 30 8 per cent, were implanted, and 30, or 17 1 per cent, were developing normally at autopsy In actual fact the capacity of the 'half'-blastocysts to become implanted and continue development is at least twice as great, since only 50 per cent of the transplanted blastomeres are present in the genital tract of the recipients before implantation

A series of 'half'-embryos on successive days of pregnancy, from the fifth to the fifteenth, was obtained All the embryos were completely normal in structure In the period from the fifth to the tenth day their size, calculated by adding up the areas of the sections, does not exceed half the size of the normal control embryos of corresponding age The statement made by Nicholas and Hall[1] that the size of rat embryos developed from 'half'-blastomeres comes within the limits of variation of the size of normal embryos is therefore somewhat surprising In the first half of pregnancy, the rate of morphogenesis of 'half'-mouse embryos is in certain cases completely normal, and in others slightly slowed down Delay in reaching the successive stages never exceeds 24 hr and most often is considerably less

Two periods of intensified resorption of 'half'-embryos may be noted—one immediately following implantation, and the other at the beginning of the second half of pregnancy, about the eleventh day On the eleventh day certain 'half'-embryos reach the stage and size characteristic of normal development , others correspond to tenth-day normal embryos Dead embryos are also encountered From the twelfth day on, the number of resorbed embryos increases markedly On the other hand, all the surviving embryos are already at the same stage of development and of the same size as the normal ones Rapid increase in the rate of development of 'half'-embryos, which takes place at this time, seems to be caused by two factors (1) real increase in the rate of growth connected with the beginning of functioning of the chorio-allantoic placenta, (2) apparent hastening of development due to elimination of most retarded embryos by resorption

Since all the embryos undergo normal development until the eleventh day, and complete regulation may be said to have taken place, resorption must be only the result of disturbance of the normal relations between mother and embryo, connected with considerable retardation in the rate of development

In view of my observations it seems that resorption of all 'half'-rat embryos during the first half of pregnancy, reported by Nicholas and Hall[1], had been caused to a large extent by improper experimental technique

Three females gave birth to young which had developed from 'half'-blastomeres (first female, 1 young one after 20 days , second female, 2 young ones after 19 days , third female, 3 young ones after 20 days) These young comprised four females and two males All the animals were fertile, and each female gave birth to several litters No abnormalities of the kind described by Seidel[2] or elsewhere were found in the young or in the more advanced embryos

A full account of this work will be published in *Acta Theriologica*

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METABOLIC AND CHEMICAL STUDIES OF 'MYLERAN': FORMATION OF 3-HYDROXYTETRAHYDROTHIOPHENE-1,1-DIOXIDE *IN VIVO*, AND REACTIONS WITH THIOLS *IN VITRO*

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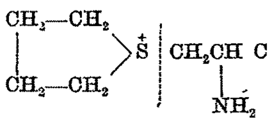
IT has been reported recently[1] that the S-β-alanyl-tetrahydrothiophenium cation (I) is formed by the reaction of dimethanesulphonyloxybutane ('Myleran') with cysteine This compound is labile under a variety of conditions, decomposing to tetrahydrothiophene, in which the sulphur atom has been derived from the cysteinyl moiety Thus treatment with mild alkali (pH 8–9), electrolysis of its aqueous solution, or pyrolysis at 140° C lead to a nearly quantitative conversion into tetrahydrothiophene

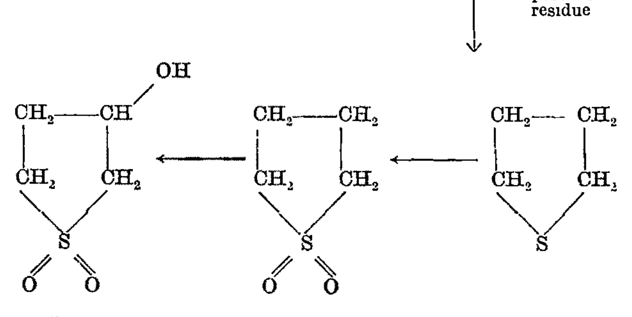


(I)

Since rats which had received injections of either 2,3-^{14}C-'Myleran' (prepared by Dr P Brookes) or the corresponding labelled sulphonium compound (I) excreted the same major urinary metabolite, it seemed very likely that intermediate formation of a sulphonium compound of this type occurred also *in vivo* after injection of 'Myleran' On the basis of the *in vitro* findings which demonstrated the lability of the sulphonium compound and the course of its decomposition, it was suggested that the major urinary metabolite was a derivative of tetrahydrothiophene This has now been established, since injection into a rat of ^{35}S-tetrahydrothiophene (II) again led to the excretion of only one major metabolite, identical with that formed from 'Myleran' and the sulphonium compound as judged by its chemical properties, and its R_F value in several solvent systems It was thus further evident that the metabolite contained a sulphur atom The fact that it failed to give a positive test for sulphur on paper chromatograms suggested that one of the changes which had occurred involved oxidation of the sulphur atom ^{35}S-Tetrahydrothiophene-1,1-dioxide (III), a likely product of oxidation *in vivo*, was therefore synthesized and shown to be converted in the rat into one major urinary metabolite which differed in R_F value from the parent dioxide, but which was again identical with that formed from 'Myleran', the sulphonium compound, and tetrahydrothiophene

Possible pathways for the metabolism of tetrahydrothiophene-1,1-dioxide included reduction of the sulphone group, further oxidation, or ring substitution It seemed improbable that reduction was involved in view of the marked stability of the sulphone group to reduction *in vitro* Further oxidation of the tetrahydrothiophene-1,1-dioxide could result in unsaturation of the ring, the formation of a ketone, or fission to a di-acid It was concluded that these changes had not occurred as the metabolite was unaltered by treatment with bromine or warm neutral permanganate, was unreactive towards dinitrophenylhydrazine, and was neutral as shown by passage through columns of ion exchange resins However, ring substitution by hydroxylation was considered possible, particularly in view of the enhancement of the reactivity of the ring carbon atoms towards nucleophilic reagents by the powerfully negative sulphone group The presence in the metabolite of one or more hydroxyl groups was demonstrated by its reactivity towards acetyl chloride, or benzoyl chloride in pyridine, leading to the formation of new compounds from which the metabolite could be regenerated by hydrolysis with mineral acid

Injection of necessarily small quantities of 'Myleran' into a rat had hitherto precluded isolation of the metabolite in a pure state and in quantities sufficient to isolate a derivative , but with the knowledge that tetrahydrothiophene-1,1-dioxide, a non-toxic compound, gave rise to the same major urinary metabolite, this difficulty was overcome Moreover, it was demonstrated that the same metabolite was excreted by the rabbit after injection of ^{14}C-'Myleran' or ^{35}S-tetrahydrothiophene-1,1-dioxide Large doses of tetrahydrothiophene-1,1-dioxide with a radioactive carrier were injected into rabbits, and after extraction of the urinary metabolite into chloroform


$CH_3SO_2O(CH_2)_4OSO_2CH_3$
Thiol group of cysteine, peptides or proteins
R = H, amino-acid, peptide or protein residue
R^1 = OH, or amino-acid, peptide or protein residue
OH

(IV) (III) (II)

the residual oil was treated with 3,5-dinitrobenzoyl chloride The resulting ester was recrystallized to constant specific radioactivity from methanol, and formed almost colourless prisms, melting point 195–197° C

Analysis $C_{11}H_{10}O_8N_2S$ requires
$C = 40\ 0$, $H = 3\ 0$, $N = 8\ 5$, $S = 9\ 7$, m w $= 330$
Found $C = 40\ 5$, $H = 3\ 2$, $N = 8\ 3$, $S = 9\ 4$, m w $= 340$

This same radioactive ester was prepared from the combined chloroform extracts of the urine obtained from two rabbits, one of which had received a small dose of ^{14}C-'Myleran' to act as carrier, and the other a relatively large quantity of tetrahydrothiophene-1,1-dioxide to enable separation of the derivative It was also obtained from the chloroform extract of urine from rats injected with high doses of the S-β-alanyl-tetrahydrothiophenium salt (I) containing a radioactive tracer Each derivative had melting point 195–197° C alone, and on admixture

The foregoing experiments indicate that the urinary metabolite formed from 'Myleran' is monohydroxy-tetrahydrothiophene-1,1-dioxide (IV) 2-Hydroxytetrahydrothiophene-1,1-dioxide, prepared via the 2-bromo compound[2] from radioactive tetrahydrothiophene-1,1-dioxide, was shown to possess a different R_F value from the metabolite However, the 3,5-dinitrobenzoate of an authentic sample of 3-hydroxytetrahydrothiophene-1,1-dioxide (IV) (sulpholanol), kindly supplied to us by Prof E Boyland, had melting point 195–197° C which was undepressed on admixture with the 3,5-dinitrobenzoate formed from the 'Myleran' metabolite

The metabolism of 'Myleran' in the rat and the rabbit may be represented in the accompanying scheme

In connexion with the possible mode of action of 'Myleran' it was of interest to determine whether the tetrahydrothiophene formed from the drug *in vivo* could have been derived by reaction with the thiol group of peptides such as glutathione, or with larger molecules such as proteins It has been shown that 'Myleran' reacts smoothly with the thiol group of glutathione in an alkaline medium forming tetrahydrothiophene, characterized as its mercurichloride Similarly, thiol-containing proteins such as denatured egg albumin and reduced keratin have been shown to yield tetrahydrothiophene when treated with 'Myleran' in an alkaline medium, indicating that sulphonium ion formation is not restricted to compounds of low molecular weight

This novel 'dethiolation reaction' provides additional evidence to the *in vivo* findings in support of the view that reactions of this type may be responsible for some of the diverse pharmacological properties of the bifunctional alkylating agents Sulphonium ion formation might lead to a modification of the function of certain proteins, but in addition dethiolation could conceivably have more far-reaching effects by actually altering the sequence of amino-acids in a peptide or protein chain It is hoped that work on these aspects may be continued

Full details of this work will be published elsewhere

The work has been supported by grants to the Chester Beatty Research Institute (Institute of Cancer Research Royal Cancer Hospital), from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund and the National Cancer Institute of the National Institutes of Health, U S Public Health Service

We wish to thank Prof A Haddow and Dr L A Elson for their interest in the work, and to record our appreciation for helpful discussion with many of our colleagues We gratefully acknowledge technical assistance from Miss M Morton

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REGISTRATION OF THE SPERMICIDAL EFFECTS OF DIOCTYL SODIUM SULPHOSUCCINATE

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STUDIES of the kinetics of spermicidal effects are not possible without a method for the estimation of the proportion of living spermatozoa at a given time This implies that the time required for this estimation has to be very short in relation to the period of time during which the process is to be studied By working with dark-field illumination, and using comparatively long photographic exposures, different pictures of the lucid spermatozoa, either immobile or in different kinds of movements, are obtained

For the present investigation bull spermatozoa were chiefly used Some experiments, however, were performed with human sperm cells, with identical results A buffered egg-yolk extract was used as an optically suitable diluent for the semen and the spermicidal substance[1] The optical equipment consists of a Zeiss microscope with dark-field condenser, heating stage, plane-apochromatic objective (× 10), compensating plane eyepiece (× 8), and a Zeiss carbon arc-lamp for microscope use The microscope carries a Leica camera, somewhat modified in order to facilitate a fast winding-on of the film Using the Kodak film 'Tri-*X*', 1 0 sec is found to be an appropriate time of exposure Prints of the negatives are enlarged five times The final linear enlargement is thus 400 times

For each determination of the percentage of mobile spermatozoa two exposures are made with an interval of 1 0 sec On the first picture the moving spermatozoa leave tracks according to their different ways of moving A comparison between the first and the second picture in a pair reveals whether doubtful cases depend upon passive motions induced by other spermatozoa or upon active movements It also renders possible classification of cells disappearing by swimming in the direction of the optical axes as moving

When performed with all precautions two counts on the same sample generally do not differ by more than 1 5 per cent All the operations described below are performed at 37° C with materials which have been preheated to this temperature Of the semen, diluted to give about 20,000 spermatozoa/μl, that is,

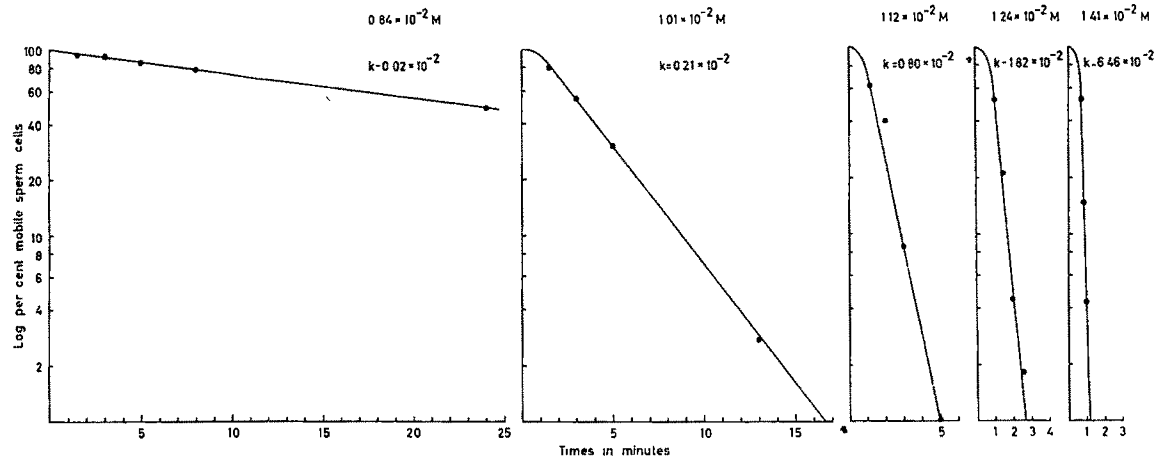

Fig 1 Semi-log plot of percentage of mobile sperm cells versus time in minutes at different concentrations of dioctyl sodium sulphosuccinate k, Apparent death-rate constant

twice the final density wanted, 0 5 ml is brought into a thick-walled test-tube provided with a rod-shaped magnetic stirrer The tube is placed in a rotating (180 r p m) magnetic field and 0 5 ml of a solution of the spermicidal substance in diluent (twice the concentration to be studied) is added, all statements as to time being related to this moment as zero About 10 µl of this mixture are put on a slide, and a coverglass provided with a fine rim of 'Vaseline' along its edges is placed on the drop in such a way that no air bubbles are left between the two glasses The preparation is thus protected from evaporation, aerobiosis being, however, permitted only for limited periods of time The first exposures are made after 60 and 61 sec , and are followed by two exposures every fifteenth and thirtieth second

A stock solution of dioctyl sodium sulphosuccinate in acetone (0 45 *M*, 20 per cent) is prepared and added to the diluent The highest final concentration of acetone in our experiments was about 5 per cent In control experiments this concentration had no effect on the percentage of mobile spermatozoa for periods of up to 2 hr

Concentrations of dioctyl sodium sulphosuccinate ranging from 0 84 × 10^{-2} *M* to 1 41 × 10^{-2} *M* (0 38 per cent to 0 63 per cent) give exponential death-rate curves that are more easily read in logarithmic form (Fig 1) As in corresponding experiments with bactericidals[2] these straight curves permit the calculation of 'apparent death-rate constants' The analytical plotting of the relation between concentration of dioctyl sodium sulphosuccinate and the apparent death-rate constants is seen in Fig 2 According to the theoretical analyses given by Johnson, Eyring and Polissar[3], these curves may give considerable information about the mechanism involved Tentatively we have transformed their expression

$$\pi = 1 - p^{m} = 1 - (1 - e^{-kt})^{m}$$

into

$$\log (1 - \pi) = m \log (1 - e^{-\lambda t})$$

and plotted log $(1 - \pi)$ against log $(1 - e^{\lambda t})$ choosing such a value of k as to give a straight line (Fig 3) This implies identical values of m and n With decreasing concentrations of dioctyl sodium sulphosuccinate both k and n decrease Log n plotted against log concentration gives a linear relationship As the concentration of the spermicide is large it remains in excess, and may thus be considered

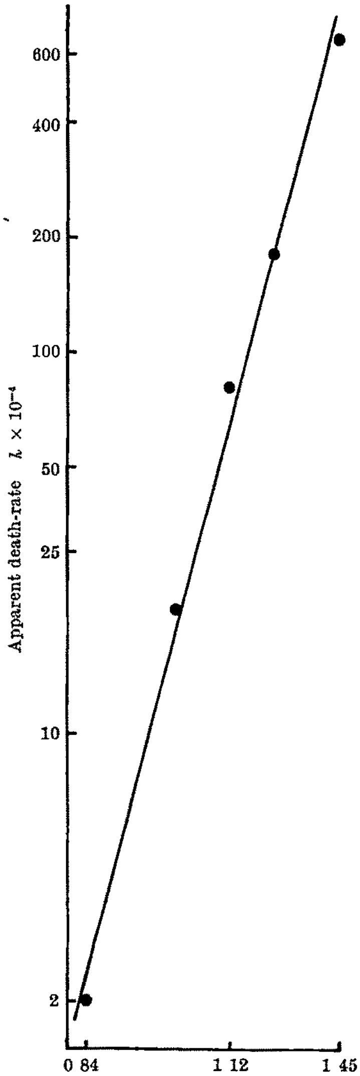

Fig 2 Log-log plot of the apparent death-rate constant versus different concentrations of dioctyl sodium sulphosuccinate

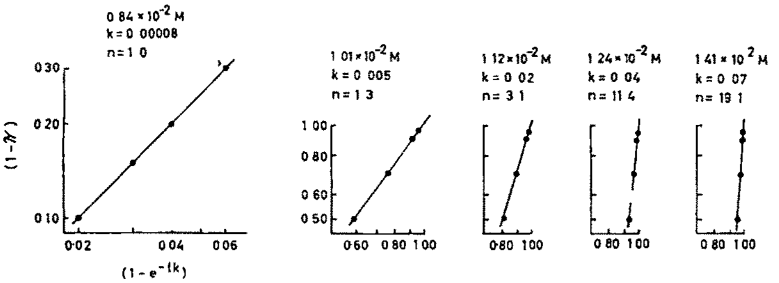

Fig. 3. Log–log plot of $(1 - \pi)$ versus $(1 - e^{-kt})$ at different concentrations of dioctyl sodium sulphosuccinate

constant[2]. According to Johnson, Eyring and Polissar *n* may thus represent the number of molecules of dioctyl sodium sulphosuccinate combining with each molecule of protein in the cells. Occasionally curves relating log surviving sperm cells to time obtained with low concentrations $(0.84 \times 10^{-2} M)$ of dioctyl sodium sulphosuccinate show a sharp break, the death-rate suddenly decreasing. This observation will be further analysed. The effects on the relationships described of anaerobiosis, temperature and ageing of the cells are being studied.

Corresponding results have been obtained with chloramin-*T* and hydrogen peroxide.

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GLUCOSE-6-PHOSPHATE DEHYDROGENASE AND HUMAN ERYTHROCYTES

Characteristics of Glucose-6-Phosphate Dehydrogenase from Normal and Primaquine-sensitive Erythrocytes

RECENT developments have emphasized the fact that genes may express themselves in terms of qualitative alterations of such macromolecules as human hæmoglobins[1] and blood-group substances[2]. Whether or not such qualitative differences at the level of the enzyme usually account for the inherited enzymic deficiencies is not known, but some instances of qualitative alterations in enzymes have been reported. Immunochemical evidence[3] exists for an inactive enzyme-like molecule in mutants lacking tryptophan-synthetase. Qualitative differences in glutamic dehydrogenase have been found in mutants of *Neurospora*[4]. An opportunity exists to explore this possibility further in the case of primaquine-sensitive hæmolytic anæmia[5], an inherited defect in which the erythrocytes of affected hemizygous or homozygous persons have only 5–20 per cent of the normal activity of glucose-6-phosphate dehydrogenase.

In order to investigate possible qualitative or quantitative differences between the glucose-6-phosphate dehydrogenase in primaquine-sensitive and normal erythrocytes, a method of partially purifying the enzyme has been developed[6,7] and preliminary comparative studies have been made. The partially purified preparation is hæmoglobin-free and represents a 60- to 80-fold purification of glucose-6-phosphate dehydrogenase in 20–50 per cent yield, with little or no contamination with 6-phosphogluconic dehydrogenase. The enzyme was assayed in final concentrations of 0.1 *M tris* buffer, *p*H 8.0, 0.01 *M* magnesium chloride, 2×10^{-4} *M* triphosphopyridine nucleotide, and 6.0×10^{-4} *M* glucose-6-phosphate, by observing the increase in optical density at 340 mμ or by measuring the 450 mμ fluorescence in a photofluorometer, using 360 mμ exciting light. Within an accuracy of ± 5–20 per cent, the preparation from both a primaquine-sensitive male and a normal male control had Michaelis constants of 2.1×10^{-6}, 3.9×10^{-5}, and 6.9×10^{-4} *M* for triphosphopyridine nucleotide, glucose-6-phosphate, and 2-deoxyglucose-6-phosphate, respectively. Both utilized the last substrate at 9 per cent of the maximum rate for glucose-6-phosphate. In a mixed buffer which was 0.05 *M* each in phosphate, *tris* and glycine, both preparations had the same *p*H-optimum curve from *p*H 6.0 to 10.0. Heat of activation (20–40° C.) was found to be 9.5×10^3 cal./mole for both preparations. Similar movement on anion-exchange column chromatography has been observed for the enzyme from both sources[7]. The percentage yield of activity for the enzyme from sensitive cells remained approximately the same as that for normal cells throughout the partial purification and all experiments. Similar labilities and the stabilizing effect of triphosphopyridine nucleotide have been reported[6]. The latter may be related to the inactivation of this enzyme by erythrocytic stroma, which has been observed by others (ref. 8 and following communication).

Because of the many identical catalytic parameters, it seems unlikely at the present time that the greatly reduced activity of erythrocytic glucose-6-phosphate dehydrogenase in these persons is due to a qualitative difference at the catalytic site of the enzyme, if a qualitative difference exists at all. We are left, therefore, with the necessity of considering a gene which manifests itself through decreasing the rate of synthesis or increasing the rate of inactivation of this enzyme. The fact that the 80-fold purified preparation can be far more extensively purified indicates that the glucose-6-phosphate dehydrogenase constitutes only a very minute portion of the hæmoglobin-free proteins and emphasizes the necessity and opportunity for more definitive comparisons of relatively pure preparations of glucose-6-phosphate dehydrogenase. Some differences in labilities[8,9] and *p*H optima[9] between this enzyme in normal and primaquine-sensitive hæmolysates have been reported. In view of the extensive contaminations with other proteins and the stabilizing effect of small amounts of various substances[6], caution should be taken in drawing inferences as to molecular differences based on differences in lability of the glucose-6-phosphate dehydrogenase between normal and primaquine-sensitive hæmolysates and crude preparations

This work has been supported, in part, by a post-doctoral fellowship, National Institute of Arthritis and Metabolic Diseases

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National Institutes of Health,
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Mechanism of Inactivation of Glucose-6-phosphate Dehydrogenase in Human Erythrocytes

IN the course of investigation of primaquine-sensitive hæmolysis we found that glucose-6-phosphate dehydrogenase is inactivated by incubation with stromata in hæmolysates of primaquine-sensitive and non-sensitive erythrocytes alike[1,2] Purified hæmoglobin-free glucose-6-phosphate dehydrogenase from both kinds of erythrocytes appears qualitatively identical and is highly stabilized by triphosphopyridine nucleotide[3]

We wish to report that in hæmolysates of both types of cells 'Norit' inactivates glucose-6-phosphate dehydrogenase by adsorption of pyridine nucleotides[4] as do stromata by pyridine nucleotidase activity Inactivation of glucose-6-phosphate dehydrogenase by stromata is prevented by triphosphopyridine nucleotide, diphosphopyridine nucleotide and nicotinamide Inactivation by 'Norit' in stroma-free hæmolysates is prevented by tri- and di-phosphopyridine nucleotide but not by nicotinamide Dialysed stroma-free hæmolysates retain bound coenzyme and, in them, glucose-6-phosphate dehydrogenase is not inactivated by incubation unless stromata or 'Norit' is added Glucose-6-phosphate dehydrogenase inactivation and removal of bound coenzyme occur concomitantly during incubation with stromata or 'Norit'

Human erythrocytes washed with cold 0 145 *M* sodium chloride were hæmolysed by rapid freezing and thawing The hæmolysate was diluted with four or five volumes of cold water , the stromata were removed by centrifuging for 60 min at 28,000*g*, 0° C either before or after incubation After dialysis (usually overnight) in 0 067 *M* phosphate buffer, *p*H 7 4, the hæmolysates were assayed for glucose-6-phosphate dehydrogenase and 6-phosphogluconic dehydrogenase activity by a modification of the coupled reactions with glutathione reductase previously described[1] In a final volume of 7 0 ml the complete reaction mixtures contained : (1) *tris*-hydroxymethylaminomethane, $5 \times 10^{-4} M$, adjusted to *p*H 7 4 with hydrochloric acid , (2) ethylenediamine tetraacetic acid adjusted to *p*H 7 4 with sodium hydroxide, $5 \times 10^{-5} M$, (3) triphosphopyridine nucleotide (Sigma), $7 \times 10^{-8} M$, (4) oxidized glutathione, GSSG (Schwarz), $5 \times 10^{-6} M$; (5) glucose-6-phosphate (Sigma), $4 \times 10^{-6} M$ for glucose-6-phosphate dehydrogenase , or (6) 6-phosphogluconate (Sigma), $4 \times 10^{-6} M$ for 6-phosphogluconic dehydrogenase , and (7) varying amounts of hæmolysate as shown in Fig 1 Reactions were run for 15 min at 37° C , *p*H 7 4

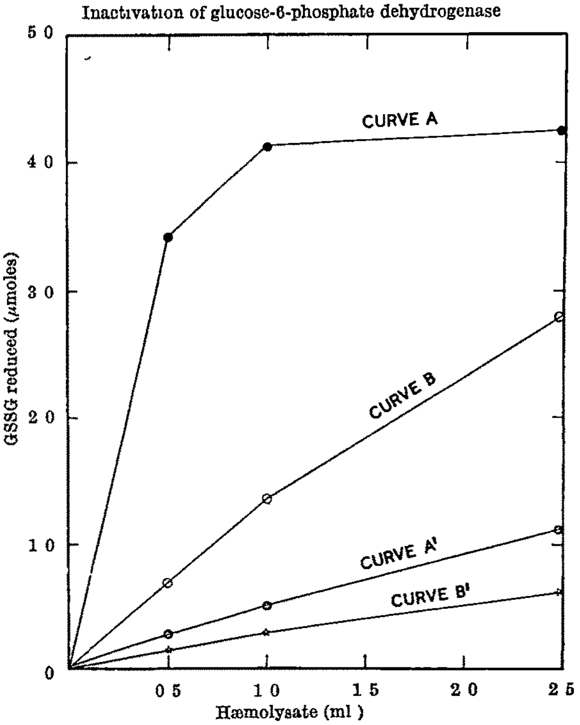

Fig 1

Fig 1 shows representative results from a male non-sensitive (*A*, *A'*) and a male sensitive individual (*B*, *B'*) Curves *A* and *B* represent activity of glucose-6-phosphate dehydrogenase in dialysed hæmolysates from which stromata had been removed immediately after hæmolysis Curves *A'* and *B'* show activity of glucose-6-phosphate dehydrogenase, after incubation of hæmolysate from non-sensitive cells for 1 hr at 45° C and from sensitive cells for 1 hr at 37° C , prior to removal of stromata Addition of tri- or di-phosphopyridine nucleotide ($10^{-4} M$) to these hæmolysates before incubation provided 100 and 73 per cent protection, respectively, based on approximate integration of the curves obtained Nicotinamide ($5 \times 10^{-3} M$) provided protection ranging from 15 to 60 per cent in non-sensitive and 60 to 100 per cent in sensitive hæmolysates

Similar incubation of doubly centrifuged stroma-free hæmolysates results in little or no inactivation either before or after dialysis However, glucose-6-phosphate dehydrogenase is inactivated in stroma-free hæmolysate by incubation with acid-washed 'Norit' (2 5–30 mgm per ml) or by incubation after removal of 'Norit' Triphosphopyridine nucleotide completely protected glucose-6-phosphate dehydrogenase in stroma-free hæmolysates incubated after removal of 'Norit' Diphosphopyridine nucleotide protected it in non-sensitive hæmolysates by 47 per cent and in sensitive hæmolysates by 91 per cent However, nicotinamide gave no protection, suggesting that its effect occurs by inhibition of stroma factor, whereas tri- and di-phosphopyridine nucleotide stabilize the enzyme itself

Glutathione reductase and 6-phosphogluconic dehydrogenase in hæmolysates, unlike glucose-6-phosphate dehydrogenase, remain active even after incubation with stromata or 'Norit' This allows preliminary investigation of the binding of triphosphopyridine nucleotide to glucose-6-phosphate dehydrogenase because the former is also the coenzyme of 6-phosphogluconic dehydrogenase Stroma-free dialysed hæmolysates retain sufficient triphosphopyridine nucleotide for the hæmolysate to reduce GSSG in 1 hr at 37° C when 6-phosphogluconate, but not triphosphopyridine nucleotide, is added to the reaction mixture However, under the same conditions, GSSG is not reduced after incubation with stromata or 'Norit' (Triphosphopyridine nucleotide is retained in hæmolysate which has been dialysed for as long as 42 hr)

The inactivation of glucose-6-phosphate dehydrogenase and loss of triphosphopyridine nucleotide remaining in dialysed hæmolysates occur together, suggesting that the non-dialysed fraction of triphosphopyridine nucleotide is bound to glucose-6-phosphate dehydrogenase and that this is active only when bound with its coenzyme The 6-phosphogluconic dehydrogenase does not bind triphosphopyridine nucleotide or require it for stabilization

Intact human erythrocytes have pyridine nucleotidase activity, both on the surface and within the cell the surface activity is demonstrated by the inactivation of glucose-6-phosphate dehydrogenase in isotonic hæmolysates during incubation with whole human erythrocytes , the intracellular effect is shown by a loss of glucose-6-phosphate dehydrogenase activity and bound triphosphopyridine nucleotide in erythrocytes incubated in isotonic saline for 2 hr at 45° C Although no loss of glucose-6-phosphate dehydrogenase activity occurred during storage of non-sensitive blood, gradual loss of glucose-6-phosphate dehydrogenase activity in sensitive blood during four weeks of storage in acid–citrate–dextrose solution also suggests an intracellular action of pyridine nucleotidase

These results show that triphosphopyridine nucleotide stabilizes glucose-6-phosphate dehydrogenase in hæmolysates as well as in partially purified preparations and confirm the suggestion that this stabilization may be related to the inactivation of this enzyme by erythrocytic stroma (ref 5 and previous communication) Partial stabilization of glucose-6-phosphate dehydrogenase by nicotinamide is indirect, by protection of the pyridine nucleotides from pyridine nucleotidase activity of stromata Stabilization by diphosphopyridine nucleotide may also be indirect, by its enzymatic conversion to triphosphopyridine nucleotide, since diphosphopyridine nucleotide does not stabilize glucose-6-phosphate dehydrogenase of partially purified preparations[5] Nevertheless, protection of glucose-6-phosphate dehydrogenase of stroma-free hæmolysates by di- as well as triphosphopyridine nucleotide indicates that the former can help to stabilize glucose-6-phosphate dehydrogenase in human erythrocytes, even though it is not a coenzyme for it The key to the mechanism of primaquine hæmolysis, and possibly of cellular ageing, may be related to these stabilizing processes

This work was done (in major part) under contracts *DA*-49-007-*MD*968 and *DA*-49-007-*MD*566 with the Office of the Surgeon General, Department of the Army It was also aided by a grant from the Douglas Smith Foundation of the University of Chicago

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X-RAY DAMAGE AND RECOVERY IN MAMMALIAN CELLS IN CULTURE

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As measured by the ability to sustain unlimited proliferation, the X-ray sensitivity of micro-organisms has been generally observed to be much greater than the sensitivity of important macromolecules This, in itself, has been an important reason for associating the lethal effect of X-rays with the genetic apparatus of the cell Puck and Marcus's[1] observation that mammalian cells in tissue culture were even more sensitive—10–100 times or more—than bacteria or yeasts further reinforced this view and led to their very reasonable proposal that the sensitive sites in mammalian cells are the chromosomes

If the functional integrity of the genetic apparatus is required for viability, since the survival curves of most somatic cells are sigmoid (or multihit), it might be expected that survivors after X-irradiation would be more sensitive to subsequent exposure than the parental population This follows from the fact that multihitness implies a threshold type of response (which means damage must be accumulated before an effect is observed) and hence that surviving cells accumulated a sublethal amount of damage

We have investigated the question of the presence of heritable damage in two cell lines of the Chinese hamster, *Cricetulus griseus*[2] (clone *A* ovarian tissue and strain *V* female lung tissue), propagated in tissue culture We have found that essentially all the survivors after X-irradiation did not display heritable damage, as would be evidenced by their radiosensitivity, but rather that they repaired their accumulated damage before their first division after irradiation

Our growth medium bears the designation *HU*-15 It consists of Eagles's amino-acids and vitamins[3] with glutamine at a concentration of 1 m*M* ; 4 per

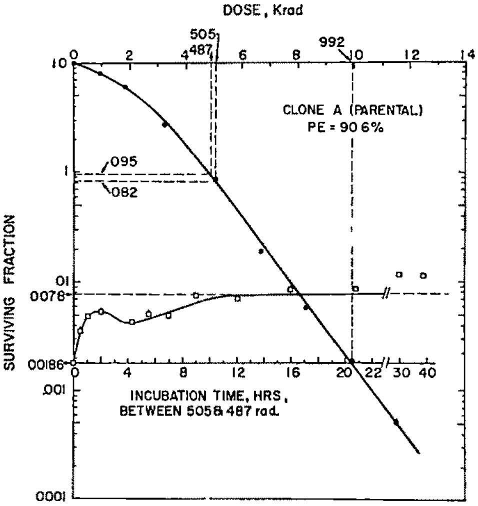

Fig. 1. Recovery of X-irradiated cells (between 505 rad and 487 rad doses) as a function of time of incubation at 37° C

cent Earle's *NCTC*-109 [4], Puck's[5] saline *F* with the calcium content increased 6.5 times, and 15 per cent undialysed fœtal calf serum (Colorado Serum Co., Denver). Both cell lines grow in this medium with a doubling time of about 12 hr.

Our X-ray source consisted of a Machlett *OEG*-60 tube powered by a full-wave rectified, 55 kV supply. The tube was operated at 12 m.amp. with 0.175 mm. aluminium filtration, absorbed dose-rate 720 rads/min. After the attachment of cells in 9-cm. Petri dishes, the plate covers and growth medium were removed and the cells were irradiated at room temperature in a humidified atmosphere of 2 per cent carbon dioxide in air. Surviving clones were stained and counted after 12–18 days incubation at 37° C in a 2 per cent carbon dioxide incubator. Identification of abortive colonies was facilitated by the use of a projection technique, although our results are essentially the same whether or not abortive colonies are included. Plating efficiencies in most of our experiments were about 70 per cent; essentially the same results were obtained, however, in experiments having plating efficiencies from 10 to 90 per cent.

In discussing the observations, a multihit model will be assumed for simplicity although our conclusions apply equally as well to sigmoid or threshold type survival curves in general. For lag-phase cells, clone *A* was found to display hitness numbers of 4–5 and clone *V* 6–7.

X-ray dose fractionation was employed to test for repair of accumulated damage. Fig. 1 shows a survival curve for single clone *A* cells trypsonized and plated 2 hr. before exposure. (Standard errors are indicated where larger than the plotted points.) In addition, the lower portion of the figure shows a recovery curve for cells which had received a first dose, 505 rads, followed by incubation at 37° C for various periods of time before receiving a second dose of 487 rads.

If there had been no recovery between the exposures, the two doses would have been completely additive, and the survival after a total of 992 rads would have been 0.0019. Alternatively, if there had been complete recovery between doses, the survival to the first and second doses would have been 0.082 and 0.095, respectively. The product of these latter values is 0.0078, which represents the survival corresponding to complete recovery between doses. The points to be noted are: (1) as a function of time at 37° C., the cells recover in a manner which may involve repair of sites as well as fluctuations in sensitivity; (2) for clone *A* cells, recovery appears to be complete by about 10 hr. and constant until about 25 hr.; and (3) the survival rises above 0.0078 after about 25 hr., which probably represents the effect of cellular multiplicity on survival concomitant with the onset of post-irradiation division.

The likelihood of the last point was arrived at by two types of measurements. First, we showed that the 'principle of cellular multiplicity' holds for these cells. That is, the surviving fraction of colonies containing more than one cell is shifted upward by an amount governed by the average cellular multiplicity providing that each cell in the colony has the same average sensitivity and that it must be inactivated independently to suppress post-irradiation colony formation. Secondly, an estimate of division delay following a first dose of 505 rads was made by comparing the clonal growth of irradiated cells with unirradiated controls. The comparison was made after clones had reached a size, about 100 cells per clone, which permitted an unambiguous identification of such clones as survivors. In agreement with the recovery curve in Fig. 1, the latter measurement indicated a division delay of about 30 hr.

In addition to the preceding, we have also shown that recovery can take place at room temperature unaccompanied by division in the control population.

To verify that the plateau region in the recovery curve of Fig. 1 represents complete repair of the accumulated damage resulting from the first dose, the survival curve was repeated after 505 rads followed by 18.1 hr. at 37° C. In Fig. 2, the non-fractionated survival curve was re-drawn starting from the survival corresponding to a first dose of 505 rads. The figure displays an excellent fit of the re-drawn curve to the observed points and shows that, in the exponential regions of both curves, maximum recovery shifts the survival upward by a factor equal to the hitness number. It also follows from Fig. 2 that, at least in the region of full recovery, synergism between the first and second doses is probably absent and therefore the second dose measures the degree of repair of damage resulting from the first dose.

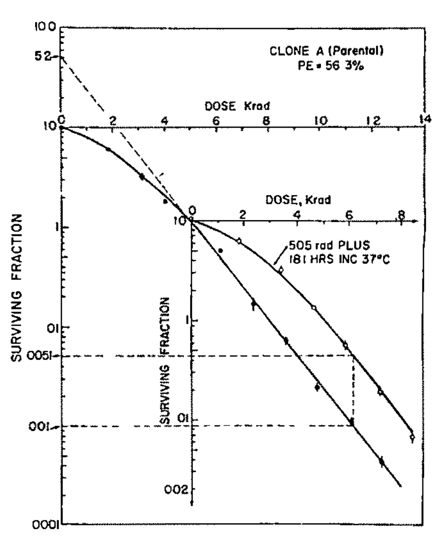

Fig. 2. Full recovery after a dose of 505 rads followed by 18.1 hr. at 37° C. as evidenced by the repetition of the non-fractionated survival curve

The preceding figures are part of a comprehensive study which will be reported in detail elsewhere To the extent that these and the results to be reported are typical for somatic cells in general, it should be noted that (1) The vast majority of surviving cells completely repair their accumulated damage before their first division post-irradiation This means that if the hitness number is n, in the exponential region, survivors undo the effects of a maximum number of hits which is $n-1$ (2) The kinetics of recovery depend on the physiological state of the cells and/or can be caused to appear to undergo large oscillations depending on the recovery medium These apparent oscillations may result from the combined effects of changes in sensitivity and repair of inactivated sites (3) Although there are important quantitative differences, log-phase cells respond similarly (4) A cell can undergo repeated cycles of damage and repair with no apparent attenuation of the repair process(es)

There are several contexts in which these findings are of interest If the chromosomes are the X-ray sensitive sites and chromosome breaks are the hits leading to lethality, then some new properties of restitution must be considered First, restitution goes to completion in surviving cells Secondly, the cell's ability to restitute breaks remains unimpaired after repeated doses In view of the preceding, Puck's[6] report of a high yield of mutant characteristics in the progeny of cells surviving 5–7 mean lethal doses may be applicable to the material he was using , may be evidence of a radiation-induced chromosomal lability which is expressed after recovery and during clonal growth , may imply that mutation production and lethality are not, in general, closely connected , or may indicate that the chromosomes are not the primary sensitive sites related to viability

Another area in which these results may apply is in connexion with tumour therapy Treatment protocols involving fractionation are common, permitting, in general, ample time between treatments for considerable if not complete recovery Even for situations in which the hitness number may only be 2, a simple calculation reveals that, if recovery is not duly accounted for, the survival using fractionation can be higher than expected by several orders of magnitude Of course, tissue recovery in a general sense has been recognized by radiation therapists for a long time These results, however, provide a cellular basis for this phenomenon and lend specific direction to the research that should be undertaken both to take advantage of, as well as to control, this effect

Additional experiments are planned (or in progress) to examine the influence of dose-rate on survival, and the biochemical and cytogenetic aspects of recovery

We are indebted to Dr T T Puck for a sample of his clone *A*, ovarian tissue, which has been propagated in our laboratory without recloning since August 1958 , to Dr Denys Ford for his *V* strain, female lung tissue, which was recloned in December 1958 ; and to Dr George Yerganian, who supplied the Chinese hamsters for the original explants

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TALLOWY DISCOLORATION IN CHEDDAR CHEESE

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Fat Oxidation and Trace Metals in Cheese

A SERIOUS fault in mature Cheddar cheese is the gradual appearance of bleached areas with a tallowy flavour, aptly described as 'tallowy discoloration' or 'white streak' The erratic incidence of this defect has for long hindered efforts to find the prime cause In seeking the cause, most of the chemical features examined showed little, if any, difference between normal and tallowy portions, apart from the oxidized condition of the latter The most striking differences were found in the disposition of trace metals As compared with adjacent normal cheese the copper content of the centre of tallowy portions was always much lower, often as little as a third , but the iron content was always higher, usually by about a half Experiments with threefold added copper did not affect the incidence of the tallowy defect, nor did added iron salts

When normal cheese curd was treated with an excess of warm 5 per cent iron-free brine, the portion that dissolved contained more iron than the undissolved cheese, which was shown to lose a corresponding quantity of iron Moreover, treatment for a shorter period so that less cheese dissolved, resulted in a higher iron content of the dissolved cheese This indicated the presence of an iron compound more soluble than the cheese, and also suggested a probable connexion between the salting process in cheese-making and the appearance of tallowiness

The degree of oxidation of iron in cheese was also studied Practically no ferrous iron could be extracted from young cheese , but the amount extractable increased with ageing at variable rates, some cheese yielding very little at maturity Cheese tending to tallowiness had increased ferrous iron content, while the actual tallowy seams had the highest ferrous content This occurred in seams where oxidation was most advanced, as shown by high peroxide values and also by oxidation of the sulphydryl groups of the protein These results now indicate that an important part is played by an iron complex The very low copper content at the centre of tallowy seams may be an effect of oxidation of a copper–sulphydryl compound similar to that demonstrated by Stricks and Kolthoff[1]

Most of these investigations were carried out during a period of several years In view of the recent finding by Rammell (following communication) that hæmatin compounds can cause tallowy discoloration, they support the view that these or similar iron complexes have an important influence in causing tallowy discoloration.

F. BISHOP

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Fat Oxidation and Hæmatin Systems in Cheese

MUCH work has been done in New Zealand on a defect of Cheddar cheese characterized by a coupled oxidation of the fat and carotene. The defect, commonly known as 'tallowy discoloration' or 'white streak', is seen in the interior of the cheese as bleached areas having a tallowy flavour. These bleached areas are invariably associated with cracks in the body of the cheese. The defect usually occurs only after at least 16–20 weeks storage at low temperatures (42–44° F.). Previous attempts to find the major pre-disposing cause of this defect have not been completely successful.

As I believe the defect to be similar in several ways to oxidative changes described by Tappel[1], attempts were made to show the presence of a fat-oxidizing system in cheese, using methods similar to those of Blain and Todd[2]. Such a system was found to be present in some cheese. As a result of these findings, cheese was made in which sterile, defibrinated cow's blood was added to the cheese milk. The experimental and control cheese were stored in a controlled curing room at about 55° F. for 6 weeks. Sample plugs of the cheese were then stored in the presence of air, at 32–34° F. for 4 weeks. After this time, the cheese containing the highest amount of blood (0.02 per cent in the cheese milk) had developed typical tallowy discoloration. The control cheese containing no added blood had not developed the defect; it was of normal flavour and colour.

On obtaining these results, four of the original experimental and control cheeses were cut and examined. These cheeses had been at 55° F. for 2 weeks followed by 9½ weeks at 42–44° F.—a total of 11½ weeks. Tallowy discoloration was seen in the two experimental cheeses, being more extensive in the cheese containing the higher amount of blood. The two control cheeses showed no sign of the defect.

The possibility of abnormal amounts of blood in the milk being the prime cause of tallowy discoloration must now be considered. It has been shown that, during manufacture of experimental cheese, most of any red blood cells added to the milk become concentrated within the cheese curd. This concentration is further modified by the addition of salt to the curd, resulting in a partial hæmolysis of the red blood cells. Higher concentrations of salt would then be expected to reduce tallowy discoloration. The effect of added salt provides a possible partial explanation of the results obtained by Bishop (preceding communication).

Full details of these and related experiments will be offered for publication elsewhere.

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NON-INVERTED VERSUS INVERTED PLOTS IN ENZYME KINETICS

IT was first shown, but not published, by Woolf (see ref. 1) that the Michaelis–Menten equation $v = V_m/(1 + K_M/S)$, relating the initial reaction-rate (v) of an enzymic reaction to the substrate concentration (S) can be written in three linear forms. The experimental (apparent) kinetic constants V_m (v, when $S \to \infty$) and K_M (S, when $v = V_m/2$) can be obtained from plots of the variables $1/v$ versus $1/S$, S/v versus S or v versus v/S. Since its first application by Lineweaver and Burk[2], the $1/v$ versus $1/S$ plot has been used most commonly.

However, it has been pointed out on several occasions (see ref. 3), that the v versus v/S plot, non-inverted with respect to v, has advantages over the two inverted plots, partly because it is less apt to obscure deviations from linearity. With respect to similar plots for determining the number of molecules of a small molecular compound bound to a protein, Scatchard[4] states ". . . this [inverted plot] has the disadvantage of concealing deviations from the ideal laws and of tempting straight lines where there should be curvature".

These considerations apply also to the determination of kinetic constants from enzymic reaction-rates at constant substrate concentration and varying concentrations of an inhibitor or activator (see ref. 5).

Despite the drawbacks it has remained customary, at least in enzyme kinetics, to use inverted plots in the evaluation of results. Even in a recent and authoritative text-book on enzymology[6] that treats these graphical procedures extensively, the advantages of the v versus v/S plot have not been fully recognized. For these reasons some further comment on this matter seems to be appropriate.

In an acid-base titration, or in the demonstration of the influence of the hydrogen ion concentration on the rate of an enzymic reaction, unwieldy graphs would be obtained if instead of pH the hydrogen ion concentration were used as one of the co-ordinates. This applies also to the influence of the substrate concentration on the rate of an enzymic reaction, and accordingly plots of v versus pS have been used in enzyme kinetics. The inflexion point of the theoretical sigmoid curve corresponds to pK_M.

Like other titrations, the enzyme–substrate 'titration' should be carried out over a range that includes substrate concentrations above as well as below this inflexion ('halfway') point. An ideal range is that of about one pS unit below to one pS unit above this point, that is, from about 0.1 to 10 K_M[5,7], representing roughly the range of 10–90 per cent 'saturation' of enzyme with substrate. However, such a (semi) logarithmic plot is still of little value for the estimation of the kinetic constants because it is not linear. On this basis, the advantage of the v versus v/S plot becomes immediately apparent. It can be seen in Fig. 1 that for almost 80 per cent of its course this plot nearly coincides with the v versus pS plot. It has the additional advantage over the latter of being linear, which allows V_m to be determined by extrapolation to $S \to \infty$ (intercept with the ordinate). The (negative) slope is equal to K_M.

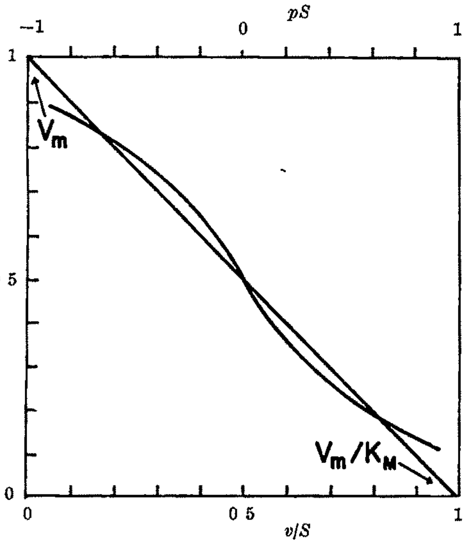

Fig 1. Comparison of the v versus pS (sigmoid) and the v versus v/S plot (straight line). V_m has been taken as unity for the reaction-rate (v) and K_M as unity for the substrate concentration (S)

If, in the ideal region, substrate concentrations are applied that correspond to about equal increments in pS, a procedure that has been found practicable in many cases (for examples see ref. 8), the reaction-rates actually measured also change by about equal increments and are equally distributed over the v versus v/S plot. This is not the case with the other two plots when equal increments of $1/S$ or S are taken. In this connexion a few comments on statements made by Dixon and Webb (ref. 6, pp. 21–22) are in order. These statements are: "... the experimenter is free to choose such substrate concentrations as will give the best distribution of points (one very rarely works at equal increments of v, indeed it is hardly practicable to do so)" and "... it is a positive advantage to have most of the points concentrated near the left hand side in [the two inverted] methods, since it is this part of the graph which is most important for determining K_M". When, in the inverted plots, the substrate concentrations are chosen so as to give equal distribution of points, one finds that the corresponding changes in rate decrease progressively at one end of the curve until they become too small to be measured accurately. On the other end of the curve, the increments in v become unnecessarily large. This is demonstrated by Figs. 2A and 2B for the case of the $1/v$ versus $1/S$ plot. Fig. 2 is based on a substrate concentration-range of about 10-fold, but one frequently finds in the literature cases where the range is even smaller so that, for example, only the lower points of curve 2B are available. Although a more or less accurate V_m/K_M value (intercept with the abscissa in the non-inverted plot) may be obtained in this case, it is obvious that neither V_m nor K_M can be estimated with any accuracy from such data, even though the inverted plot might tempt one to do so. Similar difficulties obtain when only results at the higher substrate concentrations, close to saturation, are available. From such data not even V_m can be estimated with certainty when substrate inhibition is involved.

Because only the v versus v/S plot shows the rates from $S \to 0$ to $S \to \infty$ on a finite graph, this plot generally demonstrates more clearly whether or not the results are sufficient for the estimation of the constants. When ample data are available, for example, over the recommended 100-fold range of substrate concentrations, the inverted plots are also the less convenient. As is seen in Fig. 2A, all the activities below $V_m/2$ would be found on the first small part of the curve between $1/S = 0$ and $1/S = 1$, while those above this value correspond to the range of $1/S$ between 1 and infinity. Thus, the inverted plots over-emphasize the results on one side of the curve at the cost of those on the other side. This produces a lop-sided stretching of the curve and tends to obscure deviations from linearity (see ref. 3b).

No titration is complete, nor the estimation of the corresponding constants accurate, if it is not carried through on both sides of the half-way point. Both these regions are of equal value in this respect. On the other hand, results obtained too far away from this point on either side are largely superfluous. From this it should be clear that the most important range of substrate concentrations for the determination of the constants are those of the order of K_M, around the value of which the curve should be symmetrical. This is the case only with the v versus v/S plot in which the half-way point is equally spaced between the two limiting values

$$V_m\left(=\lim_{S\to\infty} v\right) \quad \text{and} \quad V_m/K_M\left(=\lim_{S\to 0} v/S\right)$$

Another largely unwarranted comment that has been made from time to time (see ref. 9) in favour of the $1/v$ versus $1/S$ plot is based on the fact that here the variables v and S are separated. With respect to estimation of the experimental error and the weighting of data, this does not constitute an argument against the v versus v/S plot when only the error in v needs to be considered, as is most often the case. In the v versus v/S plot an error in v simply displaces the experimental point along a line through the origin that

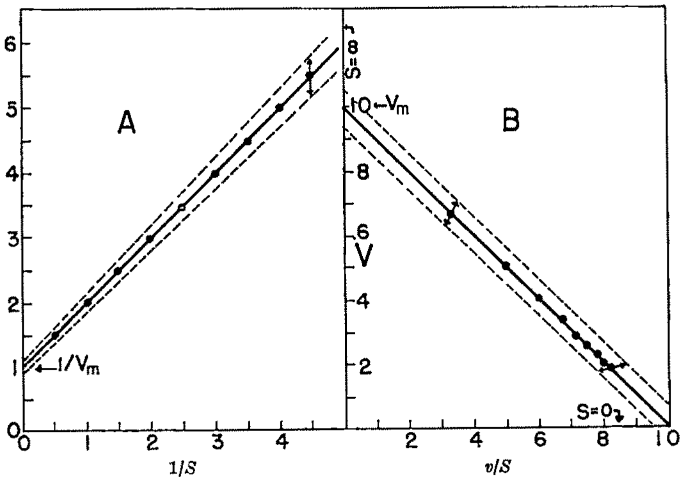

Fig 2. Comparison of the same (hypothetical) data in a $1/v$ versus $1/S$ plot (A) and a v versus v/S plot (B), showing that (1) points that are equally distributed in the inverted plot correspond to an unfavourable distribution of rates actually measured, and (2) a limited set of results that do not allow extrapolation, that is, the points on the lower part of curve B are over-emphasized in the inverted plot (A). The arrows and the zones within the dotted lines correspond to an experimental maximum error in v of ± 5 per cent

represents a particular substrate concentration The displacements are indicated by the arrows in Fig 2*A* and 2*B*, where the dotted lines show the zone in which the experimental points are found when subject to a maximum error of ±5 per cent It may be noted that in the v versus v/S plot this zone runs parallel to the theoretical curve in contrast to the inverted plot

In view of the reasons discussed above, it would seem then that there is no real basis for the continued use of the inverted plots

This investigation was supported by grant number *C*2289(*C*5) from the National Cancer Institute, National Institutes of Health, U S Public Health Service

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THERE seems to be some confusion here between two things which are in reality quite distinct, namely, (*a*) the choice of the series of substrate concentrations which will give the best results, and (*b*) the best method of plotting the results obtained These are largely independent one is free to select the best series of concentrations without even knowing which method of plotting will be used, and when the results have been obtained one is free to plot them by either method

With regard to the choice of substrate concentrations, we have in fact made no recommendation that the series should give equally spaced points on the reciprocal plot (namely, "equal increments of $1/S$"), as Dr Hofstee seems to imply, nor do we recall any such recommendation by others On the contrary, our statement that it is advantageous to have a concentration of points near the left-hand side of this plot implies approval of some such series as "equal increments of pS"

With regard to the method of plotting, both methods are of course perfectly valid, and it is our belief, based on experience of plotting results in both ways, that there is not a great deal to choose between them This is where we differ from Dr Hofstee, who believes that plot *B* (Fig 2) is so greatly superior to plot *A* that there is no reason for the continued use of the latter

The purpose of plotting is twofold (*a*) to determine K_M and V_m, and (*b*) to check that the system obeys the Michaelis equation ('linearity', that is, of the graphs) By actual use, we find that the two methods are about equally good in both respects, the accuracy of determination of the constants from a given set of results is about the same, and it seems to us that deviations from linearity are revealed almost equally well by the two methods We venture to think that if the reader will plot a few cases in both ways he will come to the same conclusion

A main argument for plot *B* seems to be that a series of concentrations of the kind commonly preferred will give a more uniform distribution of points along the straight line than in the case of plot *A* It does not follow, however, that such a uniform distribution of points will give the most accurate results, for we would point out that the position of a straight line is determined much more precisely by points near its ends than by points near its centre

Our main reason for preferring plot *A* is that one can readily identify the different points with particular substrate concentrations, and so see what is taking place This is not the case with plot *B*, which has no scale of substrate concentrations, the quantity which is plotted depends both on the arbitrarily fixed concentration and the resulting observed velocity, so that it is necessary to perform a division sum to discover what substrate concentration corresponds to a given point Any error in v affects both co-ordinates, displacing the point obliquely Also rather more calculation is involved in the actual plotting by this method We think that many workers will continue to use plot *A*, the inverted, or as we would prefer to call it, the reciprocal plot

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TWO-DIMENSIONAL HIGH-VOLTAGE PAPER ELECTROPHORESIS OF AMINO- AND OTHER ORGANIC ACIDS

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Amino-Acids

IT had been demonstrated before[1] that the application of high potential gradients to the electrophoresis of amino-acids leads to sharp separations after comparatively short running times It was felt, however, that a higher degree of resolution and greater certainty of identification of the separated compounds could be attained by the adoption of a two-dimensional technique, that is, subjecting the sample to electrophoresis on the same sheet under two different pH conditions with consequently differing migration patterns

A two-dimensional technique for the separation of amino-acids has been described by E L Durrum[2], who obtained encouraging results with mixtures of

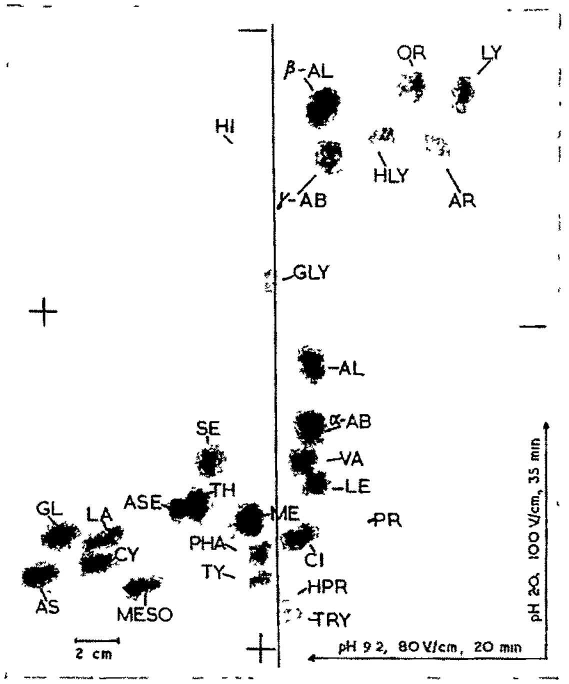

Fig 1 Two-dimensional high-voltage electrogram of amino-acids Conditions first direction (bottom to top), Whatman No 3 *MM*, 12 in × 22½ in 0 75 *M* formic acid, *p*H 2 0, 100 V /cm , 6 5 m amp /cm , cooling water temperature 16° C , pressure 1 5 lb /in ^{2}, 35 min , acidified ninhydrin reagent (0 5 per cent w/v) in acetone, 10 µgm of each amino-acid , second direction (right to left), 0 05 *M* sodium borate solution, *p*H 9 2, 80 V /cm , 9 m amp /cm , 20 min

Amino-acids *α-AB*, α-amino-butyric acid , *β-AB*, β-amino-butyric acid , *γ-AB*, γ-amino-butyric acid , *AL*, α-alanine , *β-AL*, β-alanine , *AR*, arginine , *AS*, aspartic acid , *ASE*, asparagine , *CI*, citrulline , *CY*, cystine , *GL*, glutamic acid , *GLY*, glycine , *HI*, histidine , *HLY*, hydroxylysine , *HPR*, hydroxy-proline , *LA*, lanthionine , *LE*, leucine , *LY*, lysine , *ME*, methionine , *MESO*, methionine sulphone , *OR*, ornithine , *PHA*, phenyl-alanine , *PR*, proline , *SE*, serine , *TH*, threonine , *TRY*, tryptophan , *TY*, tyrosine , *VA*, valine

up to 13 amino-acids, a potential gradient of 30 V /cm and a running time of 5 hr Several authors[3] have since reported modifications to this technique employing relatively low voltages, but without an apparent significant increase in resolving power, expediency or speed of operation A recently constructed apparatus of sufficient width and improved cooling efficiency made the application of high potential gradients (100 V /cm and greater) to two-dimensional separations of amino-acids possible[4], and the technique has since been improved and usefully employed in several investigations

The procedure found most practical is as follows a sheet of filter paper, Whatman No 3 *MM*, 12 in × 22½ in, is soaked in a 0 75 *M* formic acid solution of *p*H 2 0 and blotted to remove excess moisture The sample is applied as a streak of ½ in width, the sheet placed in the electrophoretic apparatus (sandwich type, top and bottom cooling plates, 13 in × 20 in, strictly controlled pressure) and connected through a 'Cellophane' membrane[5] at each end with the thick paper pads dipping into the electrolyte vessels It is run for up to 40 min , dried for 10 min at 90° C and 1 hr in a stream of cold air to remove most of the formic acid residue, trimmed to a length of 12 in , according to a developed guide-strip showing the effective length of separation, and sprayed lightly (approx 135 per cent moisture) from an atomizer with a 0 05 *M* sodium borate solution of *p*H 9 2 It is then turned through 90°, placed carefully in the apparatus, connected by two 12 in × 6 in paper strips to the thick paper pads and thus to the electrode vessels, the joins being made by filling in the small gaps between sheet and strips with a slurry of cellulose powder (Whatman, standard grade) in borate solution Simple overlapping interferes with efficient cooling and steadiness of moisture-level in the sheet After completion of the second run, at 100 V /cm for 20 min , the sheet is detached from the connecting strips, dried for about 15 min at 70° C and sprayed with a 0 5 per cent (w/v) ninhydrin solution in acetone, acidified by the addition of 3 per cent (v/v) of glacial acetic acid It is advisable to place the sheet for spraying with borate solution on a frame provided with a grid of nylon thread and to handle moist electrograms with rubber gloves throughout, to avoid interfering finger marks

Fig 1 shows the pattern of 27 amino-acids and amides separated by this technique

The position of glutamine coincides with that of methionine and, if the presence of both is suspected, it was found practicable to treat the applied sample with two drops of 30 per cent hydrogen peroxide before the first run, to convert the methionine to methionine sulphone[6] which is well separated from glutamine The treatment only works in an acid medium Taurine and cysteic acid can easily be separated from all the other amino-acids at *p*H 2 0 and their identification requires no confirmation by a run at a different *p*H In this case, they would be below tryptophan, separated by a wide gap from it and from one another The position of tryptophan at *p*H 2 0 was always found as shown and not, as J K Whitehead reported[3], near glycine

Fig 2 demonstrates the application of the technique to a commercial sample of acid-hydrolysed casein

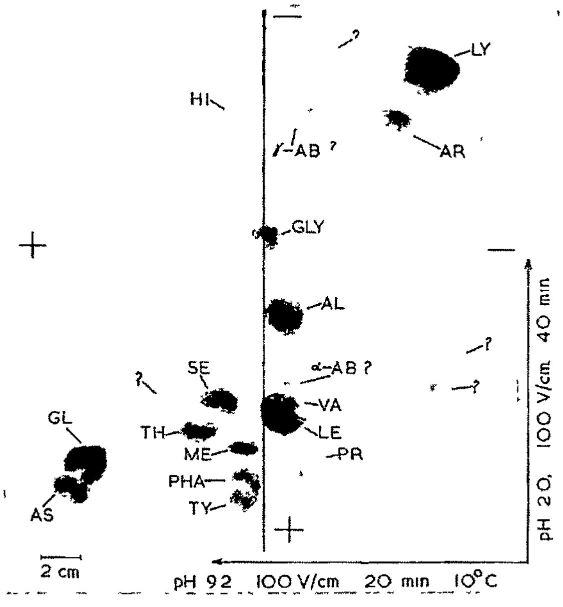

Fig 2 Two-dimensional high-voltage electrogram of a casein hydrolysate

Conditions first direction (bottom to top), Whatman No 3 *MM*, 12 in × 22½ in , 0 75 *M* formic acid, *p*H 2 0, 100 V /cm , 6 m amp /cm , cooling water temperature 10° C , pressure 1 5 lb /in ^{2}, 40 min , ninhydrin reagent as in Fig 1, 250 µgm of hydrolysate , second direction (right to left), 0 05 *M* sodium borate solution, *p*H 9 2, 100 V /cm , 9 5 m amp /cm , 20 min

Amino-acids as in Fig 1

Most of the common amino-acids can be identified by their positions, the appearance of some spots in unusual positions may be due to the presence of peptides or other ninhydrin-reactive compounds No attempt has been made to identify the compounds against which question marks are placed The partial overlapping of valine and leucine (or the leucines) is due to their relatively high concentrations The slight difference in migration distances in the second direction is due to a lower temperature and moisture content of the sheet Under standardized conditions the degree of reproducibility of the spot patterns is usually high The time for the separation of less complex mixtures can be reduced in many cases to about one half

Other Organic Acids

As a result of a systematic study of the migration-rates of non-volatile organic acids under varying conditions of pH, ionic strength and composition of background electrolyte[7], it was found possible to improve greatly the resolution of complex mixtures by choosing three well-tested buffer or electrolyte solutions of pH 2 0, 4 0 and 8 9 with advantageous differences in rate and sequence of migration

With the availability of an improved electrophoretic apparatus of sufficiently large dimensions[4], the feasibility of a two-dimensional technique became apparent and was successfully tried The two-dimensional technique, as in paper chromatography, allows the best use of the resolving power inherent in the electrolyte systems chosen, particularly in conjunction with the application of a high-voltage technique ensuring clean separations with a minimum of diffusion and liquid flow effects This high degree of resolution is particularly desirable when dealing with a multitude of organic acids as potentially present in complex biological and plant extracts The previously described[8] 0 75 M formic acid solution, found most suitable for the separation of strong and moderately strong acids from weak acids, has the disadvantage of largely suppressing the ionization of the weak acids, with attendant loss of mobility

At higher pH values the degree of ionization increases appreciably and with it the mobilities of the weak acids, which makes separation and identification of the individual acids based on their varying migration-rates feasible Two electrolyte solutions, namely, a 0 5 M acetic acid solution adjusted with pyridine to pH 4 0, and an approximately 0 1 M ammonium carbonate solution of pH 8 9, were found to offer suitable variations in migration-rates without the formation of multiple spots resulting from partial dissociation Ammonium carbonate solution had proved its usefulness in the electrophoresis of inorganic acids, volatile fatty acids[9] and some non-volatile organic acids[10]

The procedure adopted followed closely that developed for the two-dimensional separation of amino-acids The first run was at pH 8 9 and the second run at pH 4 0 or 2 0 The sheet was soaked in the electrolyte and blotted before streaking the sample over a width of 2 5 cm, run and dried for 15 min at 90° C Before the second run, the electrolyte was lightly sprayed from an atomizer on both sides of the paper sheet to a sufficient degree of moistness (about 135 per cent on dry paper) to ensure electrical conductance without displacing the partially separated acids

Runs of 25-min duration in each direction were found appropriate under the electrical conditions chosen, though with less complex mixtures the time can be reduced to 15 min for each run The sheet was dried after the second run for 10 min at 85° C and kept for 1 hr in a stream of cold air to remove the residual acetic acid (formic acid required at least 3 hr) before being sprayed with a suitable reagent The choice of a useful reagent for organic acids is restricted to indicator solutions of relatively high sensitivity (provided the background has been cleared of residual traces of free acids or bases) and low stability of colours and chemical reagents producing a colour due to the presence and pH of the acid on the paper and subsequent heating The strength of such a reaction varies with the type of acid present, and its sensitivity is usually lower than that of an indicator reagent, but the stability of the colours is much higher and the presence of traces of residual electrolyte is not so critical

Of the many reagents tried, the aniline–glucose reagent with heating at 115° C was found to give satisfactory results for most acids, and the ferric chloride – potassium ferricyanide reagent[11] without heating proved useful for syringic, lactic, glycollic and tartaric acid

A 0 025 per cent solution of bromocresol purple in ethanol–water (75 25) provided a useful and sensitive indicator reagent which could also be applied prior to spraying with the aniline–glucose reagent, the latter providing a permanent record of brown spots on a near-white background Picric acid, a coloured compound, was used as a marker to indicate the progress of migration

An example of a separation of twenty organic acids is illustrated by the electrogram in Fig 3

Thanks are due to Mr R W Butters for valuable technical assistance, Mr D G Harrison for skilful

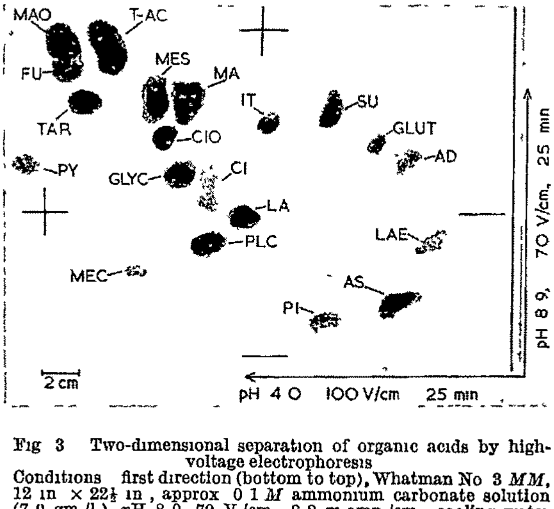

Fig 3 Two-dimensional separation of organic acids by high-voltage electrophoresis

Conditions first direction (bottom to top), Whatman No 3 *MM*, 12 in × 22½ in, approx 0 1 M ammonium carbonate solution (7 9 gm /l), pH 8 9, 70 V /cm, 8 2 m amp /cm, cooling water temperature 12° C, 1 5 lb /in ^{2}, 25 min, second direction (right to left), 0 5 M acetic acid adjusted with pyridine to pH 4 0, 100 V /cm, 10 m amp /cm, 25 min, 50 μgm of each acid Spraying reagent glucose-aniline (approx 2 per cent of each) in ethanol–water (2 8)

Organic acids *AD*, adipic, *AS*, ascorbic, *CI*, citric, *CIO*, citraconic, *FU*, fumaric, *GLUT*, glutaric, *GLYC*, glycollic, *IT*, itaconic, *LA*, lactic, *LAE*, lævulinic, *MA*, malic, *MAO*, malonic, *MEC*, meconic, *MES*, mesaconic, *PI*, picric, *PLC*, pyrrolidone-carboxylic, *PY*, pyruvic, *SU*, succinic, *T-AC* *trans*-aconitic, *TAR*, tartaric photographic work and the directors of Tate and Lyle, Ltd., for permission to publish this communication.

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ACTION OF MANGANESE DIOXIDE ON SIMPLE CARBOHYDRATES

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UNDER mild conditions, manganese dioxide (MnO_2) selectively oxidizes αβ-unsaturated alcohols to the corresponding carbonyl compounds[1], N-alkyl and N,N-dialkylanilines are also attacked, yielding amides[2]. Elevation of the temperature (70–120°) results in a reduced selectivity of oxidizing action and a variety of reactions have been observed[1,3], some of which were carried out in aqueous media. We now report a preliminary qualitative survey of the action of manganese dioxide on simple carbohydrates.

Initially the activity of manganese dioxide preparations obtained by the following methods were compared: (1) alkali-permanganate[4], (2) acid-permanganate[5], (3) decomposition[6] of manganese oxalate at 250°, (4) decomposition[6] of manganese carbonate at 250°, (5) preparations (1)–(4) after nitric acid treatment[6]. The alkali-permanganate product gave an aqueous extract *p*H *c.* 10 even after multiple treatments with water, but the remainder gave neutral extracts. Three reaction conditions were employed in which a solution of the carbohydrate (50 mgm.) in water (1·5 ml.) was vigorously shaken with manganese dioxide (*A*) 50 mgm. at 50° for 1 hr., (*B*) 50 mgm. at 95–100° for 1 hr., (*C*) 150 mgm. at 95–100° for 1 hr. These ratios of oxidant to substrate are considerably lower than those often used with other types of compound[1]. The filtered solutions were examined by (1) paper chromatography (downward irrigation with the organic phase of a butanol/ethanol/water (4:1:5) solvent system), (2) paper ionophoresis (enclosed strip technique[7]) with a borate buffer[8] *p*H 10 and an acetate buffer *p*H 5 and detection with aniline hydrogen phthalate[9] and alkaline silver nitrate[10]. Identification of products must be considered tentative, although the application of chromatography and ionophoresis in conjunction permits a more certain identification[11]. The chain-length of each acid formed in the oxidations was determined by ionophoresis in acetate buffer, and mobilities expressed as M_{GA} values (GA = gluconic acid) give the sequence: gluconic acid 1·00, arabonic acid 1·09, erythronic acid 1·27, glyceric acid 1·54 and glycollic acid 1·77.

Slight differences were observed in the effect of the various manganese dioxide preparations on glucose and fructose. The subsequent results were obtained with manganese dioxide prepared from the carbonate since it is the easiest and cheapest to prepare.

Aldoses and related compounds. From Table 1 it may be seen that the hexoses yielded pentoses together with acidic products. The hexose → pentose conversion is not a normal oxidation pathway of sugars, although it can be effected by glycol cleavage reagents[12], and amino-sugars may be degraded to pentoses by ninhydrin[13]. Both hexose and pentose were obtained *inter alia* from the heptose. The susceptibility of erythrose to oxidation was quite striking; it reacted completely under conditions *B* and *C* and hence did not appear as an oxidation product of the higher sugars other than of pentoses under condition *A*.

When galactose was treated under condition *A* with manganese dioxide, obtained from the alkali-permanganate reaction, in addition to the products shown in Table 1 traces of erythrose could also be detected, and under condition *B* epimerization occurred yielding talose and tagatose. This observation is not surprising in view of the alkalinity of the reaction solution.

Table 1. OXIDATION OF ALDOSES AND DERIVATIVES WITH MANGANESE DIOXIDE

Aldose	Reaction condition	Products*
Galactose†	*A*	Galactose, trace lyxose
	B	Galactose, lyxose, traces of 5C and 4C acids
	C	Galactose, lyxose 6C, 5C, 4C and 3C acids
D-*Glycero*-D-*galacto*-heptose	*A*	Heptose, trace mannose
	B, *C*	Heptose, mannose, traces of arabinose and 6C acid
Ribose‡	*A*	Ribose, trace erythrose, 4C acid
	B, *C*	Ribose, arabinose, 5C, 4C and 3C acids
Erythrose	*A*	Erythrose, 3C acid
	B, *C*	4C, 3C and traces of other acids (erythrose completely oxidized)
2-Deoxy-D-'galactose' 2-Acetamido-2-deoxy-D-glucose	*A*, *B*, *C*	Traces of unidentified products
3-O-methyl glucose	*A*	3-O-methyl-glucose, trace 2-O-methyl-arabinose, 6C acid
	B, *C*	3-O-methyl-glucose, 2-O-methyl-arabinose, 6C acid
Rhamnose	*A*	Rhamnose, 5-deoxy-arabinose, 5C acid
	B, *C*	Rhamnose, 5-deoxy-arabinose, 5C, 4C, 3C acids
2-Amino-2-deoxy-D-glucose hydrochloride	*A*, *B*, *C*	Complex mixture of products

* Traces of unidentified compounds were detected in several cases and manganese ions were invariably present. This comment is also applicable to the results in Tables 2 and 3.

† Parallel results with glucose, mannose and other hexoses.

‡ Parallel results with xylose and arabinose.

Table 2 ACTION OF MANGANESE DIOXIDE ON SOME REDUCING DISACCHARIDES

Disaccharide	Linkage	Reaction condition	Products*
Sophorose	β 1 → 2	*A*, *B*, *C*	Insignificant reaction
Laminaribiose (M_G 0 66)	β 1 → 3	*A*	Laminaribiose, trace *G-A* (M_G 0 33), trace acid P (M_{GA} 0 73)
		B, *C*	Laminaribiose, *G-A*, P, glucose, arabinose
Maltose (M_G 0 30)	α 1 → 4	*A*	Maltose, trace *G-A* (M_G 0 56), trace *G-T* (M_{GA} 0 76)
		B, *C*	Maltose, *G-A*, *G-T*, glucose
Cellobiose (M_G 0 26)	β 1 → 4	*A*	Cellobiose, trace *G-A* (M_G 0 57), trace *G-T* (M_{GA} 0 77)
		B, *C*	Cellobiose, *G-A*, *G-T*, glucose, arabinose, *Q* (M_G 0 30)
Melibiose (M_G 0 74)	α 1 → 6	*A*	Melibiose, trace *Gal-A* (M_G 0 87), trace *R* (M_G 0 42)
		B, *C*	*Gal-A*, *R*, trace acid *S* (M_{GA} 0 94), trace galactose and lyxose

* *G–A* indicates glucosyl–arabinose *G–T* indicates glucosyl-tetronic acid *Gal-A* indicates galactosyl-arabinose M_G value is the ionophoretic mobility in borate buffer with respect to that of glucose (ref 11), R_G value is the paper chromatographic mobility with respect to that of glucose

Enhanced resistance to oxidation is conferred by the absence of a C_2-hydroxyl group (2-deoxy-D-'galactose') and substitution at C_2 (2-acetamido-2-deoxy-D-glucose) The results with 3-O-methyl-D-glucose and rhamnose indicate that manganese dioxide oxidations might have some value for the synthesis of, for example, O-methyl- and deoxy-pentoses Although a chromatographic separation of the product would be necessary, application of this technique is also frequently essential in the more classical synthetic methods

Reducing disaccharides In examining the behaviour of disaccharides with manganese dioxide the analytical methods noted above were supplemented as follows The acidic products were separated from the neutral components by absorption[14] on 'Deacidite *FF* 530' (CO_3'' form) followed by elution with ammonium carbonate The neutral and acidic products were then hydrolysed separately with 2*N*-hydrochloric acid at 95–100° for 3 hr, and after neutralization with methyl di-*n*-octylamine[15], the hydrolysates were examined by chromatography and ionophoresis

From Table 2 it is seen that the disaccharides yielded less complex mixtures on oxidation than did the aldoses The 1 → 2 linked disaccharide (sophorose) was largely unaffected by manganese dioxide, whereas the 1 → 3, 1 → 4 and 1 → 6 linked disaccharides were each degraded to give mainly a glucosyl–pentose together with a small amount of apparently a glycosyl–glyconic acid Small amounts of hexose and pentose were also formed, but no 6-carbon or smaller acids As might be expected from the aldose oxidations, glucosyl–tetroses did not accumulate on oxidation of the 1 → 4 and 1 → 6 linked disaccharides The use of a large excess of oxidant did not completely convert maltose into its oxidation products These results suggest that manganese dioxide oxidation might provide a convenient method for converting suitable hexosyl hexoses into hexosyl-pentoses (Glycol cleavage reagents might also be used for this purpose[12]) Although a column chromatographic separation would be necessary to isolate the required product, it should be noted that, with the 1 → 3 and 1 → 4 linked glucosyl–glucose oxidation mixtures, the markedly different M_G values of the glucosyl–glucose and the glucosyl–pentose create an ideal situation for the application of borate–charcoal–'Celite' chromatography[16] Further, the sensitivity of the 1 → 3 linked disaccharide (laminaribiose) towards lime-water permits[17] complete destruction of unoxidized disaccharide, leaving the 1 → 2 linked glucosyl–pentose unaffected

Ketoses and miscellaneous compounds From Table 3 it is seen that fructose variously yielded tetrose or underwent epimerization in addition to the formation of acids Inosose, sodium gluconate and glucurone were readily oxidized, but most of the products of these reactions have not been identified and they are being actively investigated The conversion of hexitols to hexoses and pentoses is of interest The symmetrical hexitols (galactitol and mannitol) gave a single hexose and pentose, whereas glucitol gave two hexoses and two pentoses, indicating attack at both ends of the carbon chain

It is clear that a wide range of carbohydrates is attacked by manganese dioxide and that a variety of oxidation pathways is operative Some of the reactions may be of potential value for the preparation of otherwise inaccessible carbohydrates

A number of commercially available oxides were also examined for action on galactose and fructose under condition *A*

Zinc oxide (ZnO), cadmium oxide (CdO), nickel oxide (Ni_2O_3) and black and grey cobalt oxide (Co_2O_3—Co_3O_4) caused slight epimerization

Zirconium dioxide (ZrO_2) and lead oxides (PbO_2, PbO and Pb_3O_4) showed weak manganese dioxide-type properties (namely, galactose → lyxose), but PbO and Pb_3O_4 effected slight epimerization There was negligible effect on fructose Under condition *B* almost complete destructive oxidation of the substrates occurred with the lead oxides

The following oxides displayed no oxidative action HgO (red and yellow), Hg_2O, UO_3, Cu_2O, CuO, Bi_2O_3, SnO, SnO_2, MoO_3, Nb_2O_5, Y_2O_3, Sb_2O_3, Fe_2O_3, Fe_3O_4, GeO_2, V_2O_5, Cr_2O_3, TiO_2

Table 3 OXIDATION OF CARBONYL-CONTAINING AND OTHER CARBOHYDRATES

Compound	Oxidation condition	Products
Fructose*	*A*	Fructose, tetrose, 5C acid
	B, *C*	Fructose, glucose, mannose, 6C, 5C, 4C and 3C acids
Inosose	*A*, *B*, *C*	Inosose, mixture of acids and reducing acids
Sodium glucuronate†	*A*	No significant effect
	B, *C*	Glucuronic acid, trace of 4C, 3C acids, dicarboxylic acid and other unidentified components
Sodium gluconate‡	*A*	Gluconic acid, reducing acid, trace arabinose
	B, *C*	Gluconic acid, reducing acid, arabinose, unidentified components
Potassium glucarate	*A*, *B*, *C*	Glucaric acid, traces of reducing and acidic products
Galactitol§	*A*	Galactitol, trace galactose
	B, *C*	Galactitol, galactose, lyxose
Glucitol	*A*	Glucitol, trace glucose and gulose
	B, *C*	Glucitol, glucose, gulose, xylose and arabinose
Methyl α-D-glucopyranoside	*A*, *B*, *C*	Traces of unidentified products
Sucrose	*A*	Sucrose, trace of reducing component *S* (M_G 0 41)
	B, *C*	Sucrose, *S*, glucose, fructose and acid T (M_{GA} 0 73)

Parallel results with (*) sorbose, (†) glucurone, (‡) glucono-δ-lactone, (§) mannitol

We thank Miss B. Parkinson for experimental assistance.

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CROSS-LINKING OF CELLULOSE ACETATE BY IONIZING RADIATION

By Dr. S. H. PINNER, T. T. GREENWOOD and D. G. LLOYD
Tube Investments Research Laboratories, Hinxton Hall, nr. Cambridge

RECENT studies on the polymerization induced by radiation of allyl esters have revealed that the conversion-rate is markedly increased in the presence of polyvinyl chloride, while at the same time the polyvinyl chloride acquires a high density of cross-linking[1]. Polyvinyl chloride belongs to the class of polymers which undergo cross-linking by radiation[2], so that the presence of the allyl ester serves to enhance the action of the radiation but no alteration of mode is involved. It is known that such alterations can occur; for example, in the presence of oxygen, many polymers which are normally cross-linked by radiation may become degraded[3]. An artificial means of rendering a change in the reverse direction constitutes a worth-while objective, as the benefits of cross-linking could then be extended to a large class of polymers such as poly*iso*butylene and cellulose derivatives, but such means have not hitherto been described.

The enhancement of the density of cross-linking in polyvinyl chloride by the presence of the allyl ester was of such magnitude that it seemed feasible to cross-link by radiation, in this way, those polymers the normal response of which to radiation is degradation. Experiments with poly*iso*butylene and polymethyl methacrylate have given ostensible evidence of cross-linking while with secondary cellulose acetate the results leave no shadow of doubt that heavy cross-linking can be achieved. This polymer, like polyvinyl chloride, is normally plasticized to facilitate processing and advantage could thus be taken of the plasticizing action of the allyl ester.

The most obvious effect of replacement of normal plasticizers in cellulose acetate by a convertible plasticizer such as triallyl citrate was that irradiation caused a pronounced increase in tensile strength. This is shown in Fig. 1, where the tensile strength at room temperature of a composition initially containing 32 per cent triallyl citrate is given as a function of the radiation dose, using 2-MeV electrons from the scanned beam of a Van de Graaff accelerator. As shown in the accompanying curve, normally plasticized cellulose acetate exhibited no change in tensile strength over the dose-range studied, despite the radiation damage which was betrayed by darkening, bubbling and reduction in ultimate elongation.

Elevation of the tensile strength at room temperature provided evidence for the polymerization of the triallyl citrate but not, in itself, of cross-linking of the cellulose acetate. The accepted criteria for cross-linking are non-fusibility, non-solubility and reversible high elasticity. Measurements of fusibility were inappropriate in the present instance because of the high melting point of secondary cellulose acetate (*c.* 300°) (ref. 4). Measurements of rubber-like behaviour were similarly thwarted by the inherent stiffness of cellulose acetate chains, and only solubility and swelling criteria can be employed. As is well known, secondary cellulose acetate can be dissolved rapidly in acetone. By contrast, irradiated solid solutions of secondary cellulose acetate in triallyl citrate were highly resistant to acetone. This is shown in Fig. 2, where for a composition containing 32 per cent triallyl citrate, the gel fraction (24 hr. Soxhlet extraction with acetone) and the swelling index (24 hr. in acetone at room temperature) are given as a function of dose. Even a dose as low as 10 Mrads has sufficed to confer a considerable degree of solvent resistance, matching that of similarly cross-linked polyvinyl chloride[1].

For the purpose of exploring the mechanism whereby cellulose acetate has been rendered insoluble, it was desirable to measure the rate of polymerization induced by radiation of the triallyl citrate. Such measurements in the solid state pose a number of problems. Physical methods are generally superior, and density, spectroscopic and relaxation methods have been used[5]. In the present instance, the rate of conversion of the ester has been followed using a Beckman *DK*2 spectrophotometer. Solutions of triallyl citrate in acetone were used to construct a calibration curve relating the absorbance of the 1·625μ allylic absorption band with the allyl concentration and this curve led, with appropriate corrections, to values for residual allyl concentration

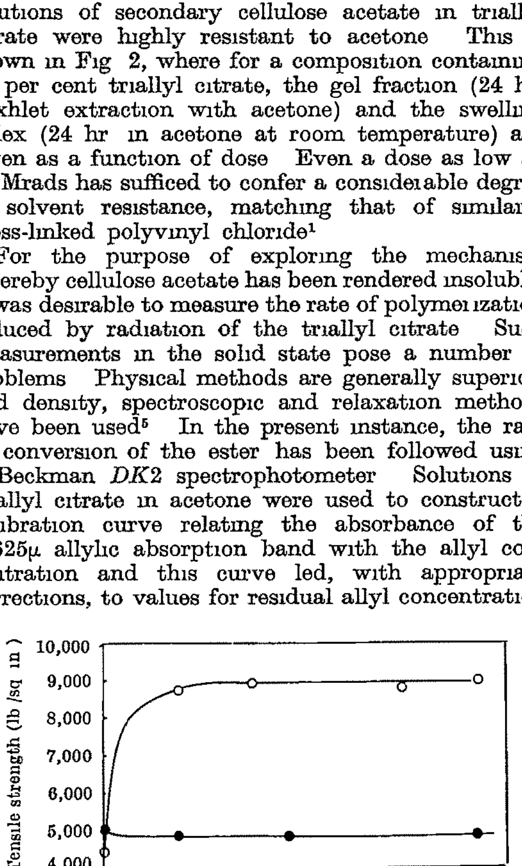

Fig. 1. Tensile strength of irradiated cellulose acetate. ●, Normally plasticized; ○, plasticized with 32 per cent triallyl citrate

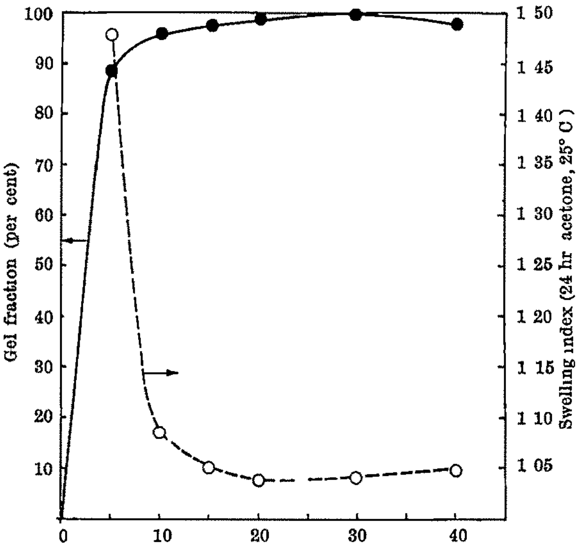

Fig 2 Solubility and swelling of irradiated cellulose acetate ●, Gel fraction (24 hr Soxhlet, acetone), ○, swelling index (24 hr acetone, 25° C)

in irradiated solid solutions of cellulose acetate in triallyl citrate The results are shown in Fig 3, whence, allowing for initial scatter, it is apparent that the disappearance of allyl is essentially proportional to dose up to at least 50 per cent conversion and that the slope is essentially independent of concentration

The average initial allyl disappearance-rate was 0 202 micromole per gram per megarad, corresponding to G (-allyl) = 200 Corresponding figures for the electron-induced homopolymerization-rate are not available, but in view of the relatively small intensity dependence of allyl polymerization, comparison may be made with the rate of homopolymerization induced by γ-rays, which at an intensity of 11,700 rads/min gives G (-allyl) = 103 (Wycherley, V , unpublished work) It follows that while some enhancement of conversion-rate in the presence of cellulose acetate has occurred, the effect is small

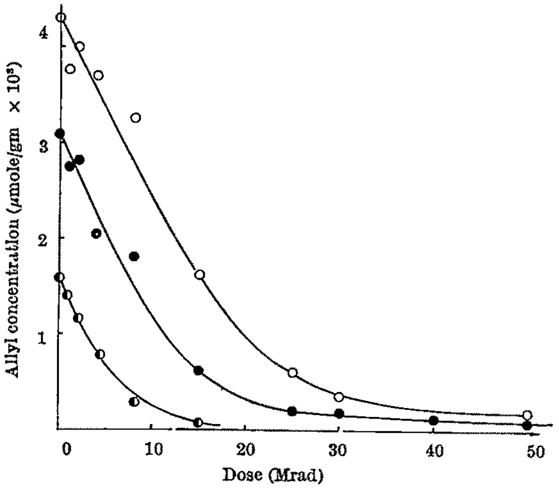

Fig 3 Variation of allyl concentration in cellulose acetate gels Composition containing ○, 45 per cent triallyl citrate, ●, 32 per cent triallyl citrate, ◐, 16 4 per cent triallyl citrate

As an initial hypothesis, it may be considered that the components of the solid solution of cellulose acetate in triallyl citrate respond independently to radiation in their characteristic fashion The hexafunctional monomer when irradiated alone has yielded gel at approximately 10 per cent conversion (Wycherley, V , unpublished work) The rate of radiolysis of cellulose acetate has not been reported, the closest approximation being the fracture-rate for irradiated cellulose, which has been given as G (fracture) = 11 (ref 6) If these processes are superimposed, it follows that the cellulose acetate component will be progressively rendered insoluble by irradiation of the mixture if it becomes attached to the allyl network at a rate exceeding that of radiolysis The mode of attachment is simply that of initiation of an allyl chain, and it remains to consider semi-quantitatively the probable rate of initiation by polymeric cellulose acetate radicals relative to that of scission

The ratio of frequency of chain transfer to frequency of propagation during normal polymerization of allyl esters lies in the range 10–20 (ref 7) Taking the mean for triallyl citrate leads to G (chain initiation) $\simeq 13$ Since the condition for cross-linking is that the probability of forming cross-linking units should be at least half the probability of dislinking, that is, $p_0/q_0 < 2$, the minimum G-value for junction point formation on the cellulose acetate in order for gel to accumulate is 5 5 While it is entirely reasonable that the G value for radical formation produced by radiation in cellulose acetate might equal 5 5, such a rate of initiation could only lead to very slow aggregation of the gel In point of fact, gel aggregation is rapid (see Fig 2), which is more consistent with a value of q_0 exceeding p_0 While G values for initiation by cellulose acetate as high as 10–15 cannot be ruled out, on present limited data, such primary initiation-rates seem abnormally high and it is more likely that a supplementary contribution is made by a process of effective chain-transfer, whereby a growing allyl chain abstracts a hydrogen atom from the cellulose acetate molecule rather than from an allyl monomer molecule, leaving the resultant macroradical to re-initiate a further allyl chain and serve as a junction point with the network In view of the similarity in the triallyl citrate conversion-rate in the presence or absence of cellulose acetate, there is no need, however, to postulate reactivation of resonance-stabilized allylic radicals, as was found necessary in the case of polyvinyl chloride[1]

If this picture is correct, it may be concluded that cross-linked cellulose acetate arises as a consequence of irradiation in the presence of a network-forming monomer, which has a short propagation chain-length and serves as an efficient trap for polymeric radicals whether produced directly by radiation or indirectly by hydrogen abstraction

This work has been carried out in collaboration with B X Plastics, Ltd , and we wish to thank Dr R R Smith and Dr M Pettit for discussion, and the Chairman of B X Plastics, Ltd , and the Chairman of Tube Investments, Ltd , for permission to publish this work

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FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, November 30

Royal Society (at Burlington House, Piccadilly London, W 1), at 2 30 p m —Anniversary Meeting

Institute of Metal Finishing (in the Canterbury Room of the Charing Cross Hotel, London, W C 2), at 2 45 p m —Mr A A B Harvey "The Role of the Scientific Society" (Presidential Address)

University College (in the Physiology Theatre, Gower Street, London, W C 1), at 5 p m —Prof E P Kennedy (University of Chicago) "The Biosynthesis of Complex Lipids" * (First of two lectures in Biochemistry Further lecture on December 7)

Royal Institution, Library Circle (at 21 Albemarle Street, London, W 1), at 5 30 p m —Dr L Pearce Williams "Faraday Through His Manuscripts"

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 8 30 p m —Prof C von Furer-Haimendorf "Sherpas of Eastern Nepal"

Tuesday, December 1

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 1 15 p m —Prof R E D Bishop "Vibration Problems in Engineering" *

Institution of Electrical Engineers, Measurement and Electronics Sections (at Savoy Place, London, W C 2), at 5 30 p m —Dr L Essen, Mr J V L Parry and Mr J McA Steele "Frequency Variations of Quartz Oscillators and the Earth's Rotation in Terms of the N P L Cæsium Standard"

University of London (at Imperial College of Science and Technology, London, S W 7), at 5 30 p m —Prof H K Porter "Physiology has No Frontiers" (Inaugural Lecture)

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 5 30 p m —Dr J L Gowans "The Lymphocyte" * (Twelfth of fifteen lectures on "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation Further lectures on December 3, 8, 10)

Plastics Institute (at the Wellcome Building, 183–193 Euston Road, London, N W 1), at 6 30 p m —Mr M R E Ashenden "Plastics and the Law"

Royal Aeronautical Society (at 4 Hamilton Place, London, W 1), at 7 p m —Dr I M Hall "Transonic Flow Over Swept Wings"

Wednesday, December 2

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 5 p m —Mr E M L Beale "Confidence Regions in Non-Linear Estimation"

Institute of Petroleum (at 61 New Cavendish Street, London, W 1), at 5 30 p m —Mr J Marechal and Mr P de Radzitsky "Potentialities of Urea in Dewaxing Middle and Heavy Distillates"

Institute of Information Scientists (at the Berners Hotel, 10 Berners Street, London, W 1), at 6 p m —Discussion on "Languages in Information Work—To What Extent is Competence in a Foreign Language an Essential Qualification for an Information Scientist ?"

Wednesday, December 2—Thursday, December 3

Iron and Steel Institute (in the Great Hall, Caxton Hall, Caxton Street, London, S W 1, and the Hoare Memorial Hall, Church House, Great Smith Street, London, S W 1), at 9 30 a m daily—Autumn General Meeting

Thursday, December 3

University of London (in the Anatomy Theatre, University College, Gower Street London, W C 1), at 1 15 p m —Mr P R Bell "The Origin of Indian Corn" *

Royal Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Mr F H C Edgcombe and Prof R G W Norrish, F R S "A Study of the Mechanism of Photochemical Electron Transfer Processes in Solution", Mr I M Dawson and Mr E A C Follett "An Electron Microscope Study of Synthetic Graphite"

Institute of Marine Engineers (joint meeting with the Institute of Naval Architects, in the Weir Hall, 10 Upper Belgrave Street, London, S W 1), at 4 45 p m —Prof G Aertssen "New Sea Trials on the Sandblasted *Lubumbashi*"

University of London (at the London School of Economics and Political Science, Houghton Street, London, W C 2), at 5 p m —Dr E R Leach "Rethinking Anthropology"* (Malinowski Memorial Lecture)

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W C 2), at 5 15 p m —Mrs Mildred Valley Thornton "Indians of British Columbia"

Institution of Electrical Engineers (at Savoy Place, London, W C 2), at 5 30 p m —Mr C B B Wood and Mr I J Shelley "The Transmission of News Film over the Trans-Atlantic Cable"

Society of Chemical Industry, Microbiology Group (joint meeting with the Society for Applied Bacteriology, at the Royal Society of Medicine, 1 Wimpole Street, London, W 1), at 6 15 p m —Dr F Brown "Infective Ribonucleic Acid from the Virus of Foot-and-Mouth Disease"

Royal Photographic Society, Medical Group (at 16 Princes Gate, London, S W 7), at 7 p m —Sir Stanford Cade, K B E , C B , F R C S "What I Want from a Medical Photograph"

Friday, December 4

Institution of Electrical Engineers, Medical Electronics Discussion Group (at Savoy Place, London, W C 2), at 6 p m —Discussion on 'Nuclear Magnetic Resonance", opened by Dr N. Sheppard and Dr R E Richards

Society of Dyers and Colourists (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 6 p m —Mr R C Oakley : "Dyeing of Ribbons", Mr R Woods "Dyeing of Carpet Yarns"

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m —Dr H A Thomas "Electronic 'Brains'"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Assistant Lecturer in Physics—The Registrar, The University, Manchester 13 (November 30)

Chair of Chemical Engineering—The Registrar, University College, Singleton Park, Swansea (November 30)

Assistant Lecturer in Physiology—The Registrar, The University, Sheffield (December 5)

Lecturer in Physiological Psychology—The Registrar (Room 22, O R B), The University, Reading (December 9)

Lecturer in Social Anthropology, and a Lecturer in Rural Sociology in the Faculty of Economic and Social Sciences—The Registrar, The University, Manchester 13 (December 12)

Organic Chemist, Scientific Officer or Senior Scientific Officer grade in the Department of Hop Research, for research problems related to the hop plant—The Registrar, Wye College, near Ashford, Kent (December 12)

Assistant Lecturer or Lecturer in Applied Mathematics—The Registrar, The University, Sheffield (December 19)

Assistant Lecturer or Lecturer in the Department of Zoology—The Registrar, The University, Liverpool (December 19).

Lecturer/Senior Lecturer (with an interest in, and qualified for teaching and research in any of the main branches of psychology) in Psychology at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, December 19)

Lecturer in Forest Pathology at the Waite Agricultural Research Institute—The Registrar, University of Adelaide, Adelaide, South Australia (December 21)

Senior Lecturer in Applied Anatomy at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, December 21)

Senior Lecturer or Lecturer in Psychology at the University of Khartoum—The Registrar, University of Khartoum, c/o Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (December 22)

Senior Principal Scientific Officer (honours graduate in science with appropriate research experience) with the Hill Farming Research Organization, to act as Deputy to the Director of the organization and, in particular, to be responsible to him for the development and coordination of the programme of research carried out by the Organization's scientific departments—The Secretary, Hill Farming Research Organization, 48 Palmerston Place, Edinburgh 12 (December 31)

Assistant Lecturer or Lecturer in Physics—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (January 2)

Reader in Medical Microbiology at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (January 15)

Lecturer or Assistant Lecturer in Psychology—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (Janaury 16)

Senior Lecturer and a Lecturer in Mathematics at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (January 29)

Administrative Assistant (male science graduate (preferably physicist) not more than 35 years old, and interested in space research) with the Secretariat of the British National Committee on Space Research—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W 1

Area Chemist (with high academic and/or professional qualifications, good general experience of modern analytical methods, and preferably well versed in the technology of lubricating oils and greases —The Director of Research (British Railways), British Transport Commission, 222 Marylebone Road, London, N W 1

Biologist (with a good honours degree in zoology and/or botany, preferably a knowledge of both subjects and some postgraduate experience) with the Fauna Research Unit, Kenya, to carry out research on Kenya fauna to provide data for the building up of life tables , details of feeding habits, enemies, predators and diseases—The Director of Recruitment, Colonial Office, London, S W 1, quoting Ref No BCD 61/7/09/C1

Botanist (Plant Pathologist) (with a good honours degree in botany or agricultural botany, and at least two years postgraduate experience in plant pathology) in the Department of Agriculture, Uganda, to diagnose the cause of crop diseases and recommend control measures, and to assist with the breeding of disease-resistant crops—The Director of Recruitment, Colonial Office, London, S W 1 quoting Ref No BCD 63/9/02/C1

Entomologist, Scientific or Senior Scientific Officer (with a good honours degree in zoology with postgraduate training or experience in entomology) at the West African Cocoa Research Institute, Ghana, for research on insect pests of cocoa—The Director of Recruitment, Colonial Office, London, S W 1, quoting Ref No BCD 197/200/02/C1

Gross Anatomist (with research interests preferably, but not exclusively, either in electron microscopy or optical (especially interference) microscopy)—The Chairman, Department of Anatomy, Emory University, Atlanta 22, Georgia, U S A

Irrigation Research Officer (with a university degree in agriculture or a science degree with agricultural experience, and training or experience in soil physics or irrigation) in Swaziland, to carry out irrigation experiments on sugar cane, citrus and other crops, and to take charge of a new experimental station—The Director of Recruitment, Colonial Office, London, S W 1, quoting BCD 63/76/014/T

Laboratory Technician (able to work with the minimum of supervision, a sound knowledge of chemistry, and some experience of biological techniques)—The Administrator, Department of Biochemistry, The University, South Parks Road, Oxford

Lecturer (well qualified physicist, and preferably with experience of the application of physics in industry) **in Physics**—The Registrar, Bradford Institute of Technology, Bradford 7

Master to teach Chemistry, principally in the Sixth Form, up to scholarship standard, with some Middle School work—The Headmaster, University College School, Frognal, Hampstead, London, N W 3

Plastics Chemist or Plastics Technologist in the Department of Materials, to assist in the organization and supervision of the teaching laboratories and to participate in the research activities of the plastics group—The Registrar, The College of Aeronautics, Cranfield, Bletchley, Bucks

Technician or Senior Technician in the Zoology Department—The Secretary, Royal Holloway College (University of London), Englefield Green, Surrey

Technician (preferably with previous experience in bacteriological work), to work in the Virus Research Laboratory at Lodge Moor Hospital—Prof C H Stuart-Harris, The Royal Hospital, Sheffield 1

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Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO , LTD ,
ST MARTIN'S STREET, LONDON, W C 2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare London

Annual subscription £7/15/–, payable in advance,
postage paid to any part of the world

Advertisements only should be addressed to
T G Scott & Son, Ltd , 1 Clement's Inn, London, W C 2
Telephone Number Holborn 4743

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TAXATION OF LEARNED AND PROFESSIONAL SOCIETIES IN BRITAIN

DURING the past two decades, the professional and learned societies have encountered increasing financial difficulties. The major institutions no longer possess the intimate and social character that once was theirs, and this may well be one factor that has encouraged the proliferation of specialist societies with only a limited range of interests. Nevertheless, even those with a membership of several thousands have encountered difficulties in maintaining the publication of professional periodicals, and this is a matter to which the Nuffield Foundation has given some attention since 1955, in co-operation with the Royal Society for scientific periodicals, and the British Academy for periodicals in the humanities. Moreover, there appears to be a marked reluctance on the part of younger scientists and technologists to join the more general societies; the tendency is to support institutions the membership of which constitutes a professional qualification.

It is probably too early to assess as yet the effect of the concession made in the Finance Act last year which allowed fees and subscriptions to professional bodies, learned societies, etc., not of a mainly local character to be claimed as expenses against income tax. When this clause was considered in the House of Commons on June 17, 1958, the Financial Secretary to the Treasury explained that while there was no logical reason to exclude the local societies, to include them would place an administrative burden on the Inland Revenue out of all proportion to the relief to the taxpayer. It was estimated that the national societies alone probably numbered about 3,000, and since the subscriptions to the local societies were usually small, the cost to the general body of taxpayers was not consonant with any relief to the individual.

During the past year, the Inland Revenue has examined the activities of the national societies in the light of the new clause, and most of the societies have already been able to notify their members that they are in a position to claim relief. If it could be shown that the membership of these societies has appreciably benefited from this concession, it might be reasonable to re-open the question of the local societies and, with the position of the national societies already clarified, the Inland Revenue should not find it an unreasonable task to deal with the local learned societies.

To the professional and learned societies, however, the effect of this concession is unlikely to be great; its main benefit is to the individual member. The concession is important, so far as the societies are concerned, in helping to offset a number of adverse factors against which most of them have been struggling: stationary or declining membership (in spite of the increasing numbers of scientists and technologists), mounting costs of printing and publication, and the steady rise in postal charges. Some of these factors could be offset by a measure of rationalization, and the pilot survey of the publishing and distribution practices of the learned periodicals carried out by Mr. Robert Lusty on behalf of the Nuffield Foundation may be regarded as a step in this direction.

A much more serious matter for the learned societies and professional institutions is, however, the complexity of rulings about the payments they make to local authorities in the form of rates. During the past three years or more, the Parliamentary and Scientific Committee has made repeated representations to the Government on this matter, submitting, for example, a comprehensive memorandum to the Minister of Housing and Local Government directing attention to anomalies in the rating of both scientific societies and research associations. During the second reading debate of the Local Government Bill in the House of Commons on December 9, 1957, the Minister announced that he intended to set up a committee to give special consideration to the rating of charities and similar organizations, and the chairman of the Parliamentary and Scientific Committee was eventually informed that the terms of reference of this committee would be wide enough to permit consideration of the special position of scientific institutions.

This committee was, in fact, appointed on January 22, 1958, under the chairmanship of Sir Fred Pritchard, "To review the present treatment for rating of hereditaments in England and Wales occupied for purposes of a charitable nature or for other similar purposes (other than hereditaments to which Section 7 of the Rating and Valuation (Miscellaneous Provisions) Act, 1955, applies), to consider in particular the provisions of Section 8 of the Act of 1955 and of the Scientific Societies Act, 1843, and to advise on the proper treatment for rating of the hereditaments within these terms of reference". The Parliamentary and Scientific Committee submitted a memorandum on the general lines of that previously submitted to the Minister of Housing and Local Government and was later invited to submit oral evidence; only the Royal Society also gave oral evidence.

The report of this Committee*, which was presented to Parliament in August 1959, is of considerable general scientific interest, quite apart from the specific recommendations and their effect on scientific or professional societies. It should be remembered that rates are the main source of revenue within the direct control of local authorities, and it is the occupier rather than the owner of a hereditament who is ratable in respect of it. The earliest general enactment still extant which exempts a specific class of hereditament from rates is Section 1 of the Scientific Societies Act, 1843, which covers societies instituted for the purposes of science, literature or the fine arts. This section exempts such societies from rates if these societies are supported wholly or in part by annual voluntary subscriptions and do not make any dividend or bonus to their members. It would seem that in granting such exemption, Parliament intended to do no more than put the buildings of such societies on a par with buildings dedicated to public purposes.

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* Report of the Committee on the Rating of Charities and Kindred Bodies. Pp. iv+86. (Cmnd. 831.) (London: H.M. Stationery Office, 1959.) 5s. net.

The commonest ground for loss or refusal of exemption has been failure to comply with the condition about support by annual voluntary contributions, and in reviewing the working of the Act, the Committee gives most attention to this condition, which has led to a good deal of litigation and is still not entirely clear. It appears that income from invested voluntary contributions is not itself an annual voluntary contribution and, in consequence, a society which depends almost entirely upon voluntary contributions but accumulates trust funds for prizes, exhibitions or scholarships could ultimately be disqualified because the investment income from contributions, although undoubtedly voluntary, was too large in relation to current activities. Moreover, the Committee could often see no difference between societies within and those without the exemption, and several societies now exempt appear to be fundamentally different from the kind of institution which members of Parliament who supported the Bill in 1843 appear to have had in mind.

The Committee was agreed that the provision could not be left unchanged, and because wherever the line were drawn there would be anomalies at the margin and any re-drafting of the conditions precedent to exemption would give rise to fresh litigation, the Committee invited the Royal Society and the Parliamentary and Scientific Committee to give oral evidence. The Committee was not, however, satisfied that any of the societies had a better claim to exemption than other charities. Most of them would be entitled under the Committee's other recommendations to 50 per cent mandatory relief as charities and, accordingly, the Committee recommended that the Scientific Societies Act of 1843 should be repealed.

Nevertheless, the Committee, like the Sorn Committee which reported in September 1954 on the Scottish rating system, recognizes that to withdraw abruptly the exemption under the Scientific Societies Act, 1843, might cause undue disturbance to the finances of the bodies concerned. It suggests, therefore, that in the first full financial year after the repeal of the provision none of the societies which was a beneficiary under it at the date of repeal should be liable for rates in respect of hereditaments which were exempt at that date. In the second year, the rates which, apart from the transitional arrangements, would have been payable by the societies concerned should be abated by four-fifths, and in the third year by three-fifths, in the fourth year by two-fifths, and in the fifth year by one-fifth. A scientific society would thus not be liable for the full 50 per cent until the sixth and subsequent years, while if it was not a charity it would pay 20 per cent in the second and 40 per cent in the third, rising to full rates in the sixth and subsequent years.

The Committee shares the general view of its witnesses that Section 8 of the Rating and Valuation (Miscellaneous Provisions) Act, 1955, which governs the rates payable by charitable and other organizations, is unacceptable as a permanent provision, and it sees no justification for giving permanent rate relief to all organizations in so wide a field. It considers that the time has come to introduce a measure of uniformity and certainty into the rating relief enjoyed by bodies within its terms of reference, and that a satisfactory scheme should be simple and economical to administer and should not add materially to the rates borne by other classes of rate-payer. Its essential basis should be mandatory relief for the great majority of the classes of organization which in the past have enjoyed some measure of relief.

It recommends accordingly that charities should have mandatory relief and that, although the decision as to the amount must be to a considerable degree arbitrary, relief of 50 per cent strikes a reasonable balance. It does not consider that there is any need to re-define the term 'charity' for rating purposes only, and in the White Paper outlining its policy on Charitable Trusts in July 1955, the Government rejected proposals for a new definition for general purposes. The Committee recommends that organizations on the fringe of the field of charity should be eligible for relief at the discretion of the local authorities, but it does not recommend that charities in general should be excluded from relief on the ground that the body is national or that it is in receipt of Exchequer grant or fees or because its voluntary income is small. The position of the universities was specially considered, but the Committee does not consider that, on balance, the exclusion of all university institutions would be justified by the evidence or arguments presented.

Representations were made to the Committee that a new statutory relief of 75 per cent should be allowed to industrial research associations, and on this also oral evidence has been heard from the Parliamentary and Scientific Committee. The Pritchard Committee, however, submits reasonably enough that research associations are much more akin to the research establishments of individual firms than to charities, and that the relief considered appropriate for research establishments conducted by individual firms within the curtilage of their industrial hereditaments should be extended to the premises of industrial research associations. This view is in accordance with that expressed in evidence by the Department of Scientific and Industrial Research.

No pronouncement has yet been made by the Government regarding its acceptance or otherwise of the recommendations of the Pritchard Committee; this matter of rating relief is only one way in which Section 8 of the Rating and Valuation (Miscellaneous

Provisions) Act, 1955, has touched the scientific and other learned societies very closely. Under the Local Government Act, 1948, valuation officers of the Board of Inland Revenue became responsible for valuation rating on February 1, 1950, with the object of securing uniform standards of valuation, and this, of course, precluded the continuation of the practice of sympathetically undervaluing hereditaments occupied by charities and kindred bodies Section 8 of the Rating and Valuation (Miscellaneous Provisions) Bill introduced in March 1955 was intended to avoid the substantial increases in liabilities for rates which such bodies would otherwise have incurred, and it was quite clear in the debates on the Bill, which received Royal Assent on July 27, 1955, that the Government fully appreciated the difficulties of the scientific and learned societies.

The Pritchard Committee in its report emphasizes that this Section of the Act provides the first statutory relief from rates for charities as such, and the first endorsement by Parliament of the relief previously given extra-statutorily by local government in various ways Further, this element of mandatory relief was introduced by the Government not, initially, as a matter of Government policy, but in deference to the wishes of the House of Commons after a provision relying entirely upon local discretion had been criticized from all quarters Moreover, this particular enactment was designed as a holding provision and never intended as a permanent arrangement.

These observations are important, as they indicate clearly the line which should be taken by scientific societies and professional organizations which may be unfairly affected in the new situation It follows, moreover, that legislation to provide some reasonable permanent arrangement is not merely probable but almost inevitable, and that it is in the debates on such legislation that the needs of the scientific and learned societies and professional organizations should be clearly and effectively presented to Parliament.

When in 1950 the valuation officers of the Board of Inland Revenue assumed responsibility for valuation for rating, they did not disturb the exemptions in the old lists unless they were asked to do so by the rating authorities , but in preparing the new valuation lists which came into force on April 1, 1956, they applied strictly the provisions of the Act of 1843 as recently interpreted by the courts In consequence, some societies which had been exempt became liable for rates on assessments based on full current rental values, and only some of those which challenged this liability in the courts succeeded Further, the Board of Inland Revenue has suspended the income tax rebate which the learned societies enjoyed on seven-year covenants entered into by their members, and for some of them has finally withdrawn the relief

This is the second aspect of the situation which deeply concerns the professional associations and learned societies and other bodies, and may affect some of them much more seriously than the concession made regarding subscriptions to such bodies in Clause 14 of the Finance Bill, 1958 Indeed, although the situation is complex and is still being argued between various bodies and the Inland Revenue, sometimes in the Court of Appeal, it would appear that those bodies which have lost the right to tax rebates on subscription income guaranteed from covenants are likely also to lose rating relief and the advantage of their members being able to claim subscriptions as expenses against income tax Probably it is not too much to say that some of the societies have only been able to meet post-war costs through the rebates in covenanted subscriptions and relief from rates which they have hitherto enjoyed

The Pritchard Committee argues lucidly and cogently for a mandatory and uniform system of rating relief It does not suggest that all anomalies will be removed or that there should be no discretionary relief It is difficult to refute the argument of an eminently sensible report, but before adopting the legislation to which the report points, Parliament might reasonably re-examine the fundamental question what is a charity for tax purposes, and especially the full and wide implications of what could not unfairly be described as an assault on learned societies launched by the Board of Inland Revenue Parliament at least, should be concerned not so much with the benefits and advantages, to particular institutions and their members, of taxation or rating relief, but with the extent to which the public interest is served by such bodies A recent survey of leisure and learning in Bolton and Rochdale pointed to the value of such societies in the world of to-day, quite apart from their place in the dissemination of knowledge and the maintenance of professional standards, and to their need of assistance in the maintenance and equipment of premises The place of the scientific and learned society in the world of to-day could be appropriately re-examined in the light of all the implications of the situation on which the Pritchard Committee has now reported

KEW, PAST AND PRESENT

The Royal Botanic Gardens, Kew

By W B Turrill Pp 256+16 plates (London Herbert Jenkins, Ltd , 1959) 25*s* net

"KEW" to botanists, horticulturists and admirers of plants the world over is the Royal Botanic Gardens, Kew, Richmond, Surrey, England Like many other famous places or institutions, the exact day of its founding is uncertain This summer, however, the Royal Botanic Gardens celebrated a birthday of approximately two hundred historic, profitable, eventful and beautiful years At this occasion grateful botanists paid tribute by manuscript, letter or personal visit Few have honoured Kew as well, though, as William Bertram Turrill does in this book It is a devoted tribute to the Gardens the author knew and served for forty-nine years until his retirement in 1957

"The Royal Botanic Gardens, Kew" is both a historical account of the development of the Gardens and laboratories and a detailed description of their current contents The book is readable, but the historical portion and that of current activities of the staff are written with so much under-statement that one longs for greater emphasis on the personality and procedures of the men who made Kew and contribute to its reputation to-day. The Royal Botanic Gardens have served as a training ground for many scientists, explorers and gardeners, but Dr. Turrill is almost reluctant in admitting the contributions of these men. Procedures, ideas and even the architecture developed at Kew were taken by students to distant lands, and one sees the influence of Kew in some aspect of every major herbarium and botanic garden of the world. A single chapter of a scant fourteen pages describes the current scientific research of nearly eighty-five people. Three pages are devoted to "Plant Introductions via Kew", and nearly half of this concerns the story of quinine. One wishes Dr. Turrill had elaborated more the credit which is due to the activities and leadership of Kew, and in basic research and practical horticulture.

The remaining chapters, particularly those on "Economic Botany and the Kew Museums", 'The Greenhouses" and Kew at various seasons, charmingly describe a tour of the exhibits, living and preserved, in infinite detail. The book will serve as a guide, supplying, where appropriate, the personal exposition of a tour leader on how trees grow or manufacture food, or how plant products are used, or where particular plants can be found. One familiar with museum and garden exhibition techniques visualizes in Turrill's account both the display and the information on the labels. At the same time, the casual reader may be unaware that chapters of a basic text-book of botany have been paraphrased to present briefly and clearly the reasons for the exhibit.

A chapter on "Wild Life at Kew" exemplifies the detail of the book in relating much information, including the introduction of the American grey squirrel and its destruction, the amount of myxomatosis in the rabbits of Kew during the year 1955, the types of weeds in the lawn or the record-sized fish caught in a Kew pond and its present location. Throughout this and other chapters are the intimate stories one gets in a personally conducted, leisurely tour by a guide who knows and loves the Royal Botanic Gardens, Kew.

Sixteen excellent plates illustrate the men and women responsible for Kew's past, the present buildings, and scenes from the Gardens. Appendixes give details on the climate, the rules and regulations, the physical plant, the composition of the staff and the chronology of the curators and keepers of the Herbarium, Library and museums. A bibliography of sixty-six titles relating to Kew, an index and a grid map, referred to frequently in the text, complete the book.

As one enjoys a garden at many hours of many seasons, so I recommend to past, present and future friends of Kew a leisurely and frequent reading of this book. RICHARD A. HOWARD

JET PROPULSION

Jets and Rockets

By A. Barker, T. R. F. Nonweiler and R. Smelt. Pp. xiv+268. (London: Chapman and Hall, Ltd., 1959.) 35*s*. net.

THE history of this book prior to publication was unusually rich, and Mr. Nonweiler recites it with relish in his candid preface. The book was begun by Mr. Smelt in 1945, and then passed to Mr. Nonweiler after the former 'went West to the States'; finally Mr. Barker brought it up to date and completed it. Although a few authentic touches of antiquity survive, most of the book has been satisfactorily modernized, and the reader need have only occasional qualms on this score.

The book is intended as an introductory text-book on all forms of jet propulsion, rocket, ramjet, turbo-jet, pulse-jet and various hybrids, and on the whole, it achieves this purpose well. The authors describe clearly the main features of each power plant, and preserve a fair balance; they do not delve very deeply into the specialized problems of each engine, but this cannot be expected in a 250-page book so wide in its scope. The chemistry of rocket combustion and the thermodynamics of the various engines—the theory underlying the calculation of thrust coefficient and fuel consumption—are presented in adequate detail; and the methods of calculating drag and the design of air intakes are also thoroughly discussed. One of the best features of the book is its emphasis on the close links between the internal thermodynamics of an engine and its external aerodynamics. This emphasis is particularly valuable because many text-books on propulsion tend to ignore the external aerodynamics, although minimizing drag can be just as important as maximizing thrust, especially at supersonic speeds.

Unfortunately, the book is marred by lack of attention to detail. Several of the formulæ are in error (e.g., equations 5.13 and 5.15), some of the graphs lack units, the spelling is erratic, misprints abound and there are many stylistic lapses. Chapter 15 is in places sadly out of date: it gives the impression that the V2 was the ultimate in rocket missiles and that space vehicles are virtually impossible. Indeed, throughout the book, German war-time engines, now museum-pieces, are too often quoted as examples, thus giving the false impression that the accompanying text is equally obsolete. On one point of detail the book is excellent: there are more than 120 diagrams and photographs, most of them pertinent, clear and informative.

D. G. KING-HELE

NUCLEAR FUEL TREATMENT

Chemical Processing of Nuclear Fuels

By Dr. F. S. Martin and Dr. G. L. Miles. Pp. x+242. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1958.) 40*s*.; 7.50 dollars.

ALTHOUGH this book is intended mainly as an introduction to the problems of chemical processing of nuclear fuel after irradiation in a reactor, its scope extends much further. In Part 1, which deals with "Nuclear Considerations", the three main systems uranium-235, uranium-238–plutonium and thorium–uranium-233 are considered separately and the reactions occurring under thermal neutron irradiation shown diagrammatically.

The several highly developed solvent-extraction processes employed in nuclear processing are described and decontamination factors listed. The requirements of a process for purifying the plutonium product of primary separation are also enumerated and the value quoted for the overall recovery of plutonium (99.4 per cent) in one process shows how highly developed this particular technology has become.

In the middle chapters, the authors survey other processes which have been considered (and in some cases developed) for the separation of heavy nuclides from fission products The range covered is sufficient to indicate the amazing volume of research which has been carried out on both sides of the Atlantic in this field—ion-exchange separations, metal distillations, halide volatilizations, extractions by molten metals, purification by slagging processes, extraction by fused chlorides as well as the more conventional (and historically important) processes of separation by precipitation

There is also a section in the book dealing with the disposal of effluents and fission product recovery, a field which has received much attention from authors, both knowledgeable and otherwise, in recent years It is sufficient to say that the treatment here is brief and chemically factual and scores on both these counts

A criticism which may be advanced, perhaps, is that the reader is not given very clearly to understand which are the most important separation processes described The dominant position now held by solvent extraction processes and the resultant commercial difficulties in the way of any competing technology are not brought out very fully But such an appreciation is not necessarily a function of this book, it is abundantly clear that it represents a valuable and important contribution to chemical literature It should find its way not only to those science and engineering graduates with some acquaintance of nuclear reactor development but also to that much wider reading public of chemists and chemical engineers who would like to read and have by them an authoritative and interesting work on the applied chemistry of nuclear power J E LITTLECHILD

FOOD ANALYSIS

The Chemical Analysis of Foods and Food Products

By Dr Morris B Jacobs Third edition Pp xxiv + 970 (Princeton, N J D Van Nostrand Company, Inc ; London D Van Nostrand Company, Ltd, 1958) 103*s* 6*d*

THE 970 pages of this book include more material than the title indicates The text includes information on the make-up of several types of food For example, the chapter on sugar foods and carbohydrates begins with a useful summary of the types of carbohydrates found in foods, the chapter on meat gives definitions of meat products and tables of typical compositions, the chapter on oils and fats contains in tabular form information on 24 fatty acids, the chapter on quality measurement includes a general introduction on flavour acceptance, while the chapter on milk comprises more than a hundred pages and includes detailed information on composition, on cheese and other products, and on adulterants

Essentially, however, the work is a practical book for use at the bench The book begins by describing general chemical and physical methods that are used in the analyses of food products Directions are given for analysing constituents of all common and some less common foods The book also includes chapters on undesirable materials in food For example, one chapter deals with filth, and includes working directions for estimating the amount of rodent excreta, maggots, rancidity, and decomposition in fish and other foods There are also chapters on pesticide residues, radiochemical determinations, food poisoning and preservatives The detection of horse meat in presence of other animal tissues is discussed Chapters are included on artificial sweetening agents and on colouring matters Instructions are even given for such details as how to count the pits in preserved cherries from which the pits have ostensibly been removed

In a few respects—for example, in spectrophotometry, in absence of mention of methyl cellulose, in determination of tocopherols and of carotene, in lack of reference to paper chromatography—the book is not up to date, but it would be impossible for so large a work to be kept up-to-the-minute by one author The book has been produced in the United States and is primarily concerned with codes of practice and food laws in that country, but in nearly all cases the information has general application The book is indeed a useful compilation

V H BOOTH

A FLORA OF THE ARCTIC

Circumpolar Arctic Flora

By Nicholas Polunin Pp xxviii+514 (Oxford: Clarendon Press, London Oxford University Press, 1959) 126*s* net

TWO problems immediately confront those who write on arctic plants first, the difficulty of defining the limits of what one proposes to term 'the Arctic', and secondly, the even greater difficulty of providing an adequate and up-to-date account of that vast and virtually inaccessible area lying east of Finland and west of the Bering straits Dr Polunin with his extensive experience of the arctic and arctic vegetation faces up boldly to the first problem and can no doubt furnish weighty arguments in favour of what appears to be a curiously involved, indeed almost tortuous, delimitation As regards the second problem, the author freely admits that our knowledge of the Soviet arctic is inadequate, and that, in present circumstances, no Western or American botanist can hope to compile a detailed and critical circumpolar flora Some may feel, this being so, that any attempt to deal with the flora of the area is bound to be premature and unsatisfactory The number of flowering plants and vascular cryptogams occurring in the Arctic is so small that the critic has some right to expect a minute and detailed analysis, and to be more exacting in his demands than if the author were attempting a survey of some tropical region with a richly diversified flora If the reader approaches Dr Polunin's book in this frame of mind he will find much to criticize, for the very frequent use of the tell-tale abbreviations *agg* and *s l* after the scientific names shows how much has still to be done before the last word can be written on this subject But half a loaf is better than no bread, and the less exacting will be glad that Dr Polunin has had the energy and enterprise to give us a concise, lavishly illustrated and, for practical purposes, a tolerably complete account of these northern plants

British botanists, whose thoughts turn not infrequently to those epochs when much of Great Britain lay buried under ice and snow, will be intrigued to see how many truly arctic species still survive from those bygone glaciations, and (bearing in mind recent records of *Koenigia, Diapensia* and *Artemisia norvegica*) some may choose to ruminate on the number and likely identity of species yet to be discovered here. Palynologists, geologists and archæologists will also find, in these pages, the sort of information that can save hours of exhausting work in the identification of doubtful grains or fragments. Two features that will certainly not be commended by botanists are the absence of author citations in the main body of the text, and the invention of popular names, some of which (for example, "Boreal Blinking-chickweed") would, in a less august environment, raise a laugh. It is a pity, too, that space should have been devoted to derivations of generic names; such learning is scarcely called for in a book of this sort. The illustrations, though uneven in quality, are on the whole very pleasant to look at, and sufficiently detailed to give us a very fair idea of each plant. Printing and format are excellent, though the regrettably high price must necessarily put the book beyond the means of many who would be happy to possess it.

R. D. MEIKLE

NEW IDEAS FOR INDUSTRY

Investment in Innovation

By C. F. Carter and B. R. Williams. Pp. ix+167. (London: Oxford University Press, 1958.) 15*s*. net.

THIS book is in effect a supplement to the same authors' work on industry and technical progress, being in the main a by-product of the case studies which were undertaken in connexion with the writing of that book under the auspices of the British Association and the Conditional Aid scheme. It is a detailed investigation, based upon case material, of the reasons why firms invest or do not invest in technical innovations. Perhaps the only brief statement that can be made about its conclusions is that it shows the enormous range of difference between firms and industries in the nature of the incentives to investment. Thus, for example, it is made clear that, in some cases, keener competition at home or abroad is an incentive to investment while in other cases protection from competition will have this effect. The effect of excess demand manifesting itself in long order books is also noted as one of the factors that have been important in some cases in recent years, and there is a careful discussion of the effect of fiscal changes in stimulating either new investment or quicker replacement of plant. The general factors which are regarded as likely to promote accelerated investment in innovations most effectively, however, seem to be the supply and wide diffusion through industry of scientifically literate people and the improvement of recruitment and training for management. It is essentially effective access to information about new technical possibilities and the willingness and ability to introduce change without creating insuperable opposition that seem to be key factors in determining the rate of industrial progress.

Not very much attention is given by the authors to the supply of capital as a factor limiting investment of the relevant kind, though they found some cases in which shortage of risk capital had been important. Their investigation, however, throws more light on the old question whether interest rate is an important controlling factor governing industrial investment. In general, they conclude from their field studies that with interest rates varying over the normal range their direct influence is slight—investment projects are either so attractive that a difference in interest rate between, say, 2 and 6 per cent will have little effect upon them or so unattractive that they will not be undertaken at any interest rate however low. The authors think, however, that there is an intermediate class of projects to which the rate of interest is critical even as things are, and that this class might be much bigger if interest rates were capable of going higher than in fact they have gone in advanced countries in modern times.

Altogether this is an extremely valuable and stimulating book belonging to the select but growing class of contributions to economics which seek answers to the really fundamental questions from direct investigation of industrial life.

A. J. BROWN

THE FUTURE OF THE ETRUSCANS

Ciba Foundation Symposium on Medical Biology and Etruscan Origins

Edited by G. E. W. Wolstenholme and Cecilia M. O'Connor. Pp. xii+255. (London: J. and A. Churchill, Ltd., 1959.) 45*s*. net.

THE publication of a Ciba Foundation symposium is always an interesting event. This volume has a stimulating title; the synthesis attempted is an innovation of some significance, and it will be viewed from many quarters with a critical eye, in order to assess the value of its application to populations other than the Etruscans.

The Foundation must be congratulated on having drawn together a group of eminent scientists and Etruscologists, and on the clear layout and attractive presentation of the volume. The illustrations show evidence of a care not always extended to the maps. The first five papers presented at the symposium give the evidence of archæology, religion and linguistics, and some space is given to discussion of the varying theories on the origins of the Etruscans which this evidence permits. As Prof. Banti points out, no one theory can be held dogmatically on the basis of the present information from these fields; and for this reason if for no other, much might be expected of the contributions of the scientists to this meeting. If, in the conclusions which may be drawn from it, the second section falls short of the reader's expectations, it must be borne in mind that the value of scientific work to such studies has only recently been appreciated; indeed, this is made clear in the discussions, in which it is admitted that skeletal material has received cavalier treatment in the past. The main value of this meeting of scientists and archæologists lies in its promise, and in the opportunity it has provided to discuss mutual requirements; many interesting possibilities are outlined by the various speakers, not the least of which is that of the blood grouping of skeletal remains. Several speakers discuss the serology of the modern population of Etruria; a feature the impact of which is somewhat spoilt by the failure of the historians to show that this region has remained genetically isolated since the Etruscan period.

This book presents an intriguing approach to an old and fascinating problem, and much can be gained from its careful outline of the requirements and pitfalls of such studies. It is likely to become a useful reference book.

MADELEINE SMITH

Khami Ruins

Report on Excavations undertaken for the Commission for the Preservation of Natural and Historical Monuments and Relics, Southern Rhodesia, 1947–1955 By K R Robinson With Reports by G Bond and E Voce Pp xvi+192+28 plates (Cambridge At the University Press, 1959) 40s net

IT seems likely that iron-working, agriculture and the manufacture of well-made pottery reached Central Africa at the same time and as elements of the same culture complex, within a century or two of the beginning of the Christian era The event marks the beginning of the history of the Bantu-speaking peoples in the area, and forms a most important field of pre- and proto-historical research None the less it is a sadly neglected field of study, and much credit must go to prehistorians working on this period in Southern Rhodesia

Miss Caton-Thompson's work on Zimbabwe is well known, and earlier this year Roger Summers produced a most important book on the terraces and ruins of Inyanga Keith Robinson's excellent book on the Khami ruins now enables us to make some sense of the third of the great ruins sites of Southern Rhodesia

The book is an excellent objective study of the ruins based on many years of intimate study, backed by carefully selected excavation It is attractively set out, with good illustrations, and in Chapter 5 the conclusions are logically and clearly presented The over-riding weakness in all three of the works mentioned is the lack of conclusive dating evidence This is no fault of the writers concerned and is entirely due to the difficult nature of the evidence Radiocarbon dates are urgently needed

It is to be hoped that the future will see a continuation of the excellent work now being done in Southern Rhodesia, perhaps, we may add, with rather more emphasis on the crucial earlier phases of the Rhodesian Iron Age R R INSKEEP

Rock Pressure in Mines

By E de St Q Isaacson Pp x+212 (London: Mining Publications, Ltd , 1958) 45s

SEVENTY-FIVE years ago Fayol published results of his investigations into ground failure While his conclusions were valid at shallow depths, it was found that at deeper levels stresses, which had little significance near the surface, began to play an ever-increasing part During the past thirty years many workers have investigated the problem, and in "Rock Pressure in Mines" we have a comprehensive account of the theoretical and practical principles that govern the behaviour of pressure in underground workings The author, who is in charge of the Rockburst Research Unit of the Kolar Gold Mines, devotes the first four chapters to theoretical considerations, dealing with elastic stresses and strains, elastic stresses in isotropic rocks around differently shaped excavations, the behaviour of rock stressed beyond the elastic limit, and modifications due to departures from homogeneity He then applies these considerations to the planning and lay-out of workings In a chapter on rock-bursts he shows how strain energy may be built up He considers that good planning coupled with destressing should substantially reduce the danger of rock-bursts Descriptions and criticisms of several occurrences are given Finally, some of the instruments suitable for measurement of stresses and strain underground are described The book is well planned and pleasingly written There are 125 simple line-drawings and some plates References to standard text-books and technical papers are adequate It is a book which will be invaluable to all who are concerned with problems of rock pressure

J K L GRAHAM

Plant Nematodes

Their Bionomics and Control By Dr Jesse R Christie Pp xi+256 (Gainesville, Fla Agricultural Experiment Stations, University of Florida, 1959) 3 75 dollars

NEMATOLOGY as a separate discipline is a relatively recent development and, as a result, the information on the bionomics and control of plant parasitic nematodes is spread widely through technical journals and bulletins This literature has not only been surveyed and compiled by the author but is also presented in a clear and logical manner The author of this relatively small book has succeeded admirably in fulfilling his declared intention of writing a work for specialists which is also understandable to others generally interested in agriculture and horticulture This he has done in fourteen chapters of which the first is a general introduction to nematodes and nematology, while the second is a general discussion of the principles of nematode control Each of the remaining chapters deals with one group of related nematodes and each is laid out in the same sequence, so far as the subject-matter will allow First, the taxonomy of the parasite, then the life-history and habits, the injury caused to the host, a list of hosts, the parasites' known distribution and methods of spread, and, finally, methods of control Five tables, in an appendix, list the parasites and their distribution, under the crop plants attacked, control measures, details of hot-water treatments, the common names of plant parasitic nematodes, and in the fifth table a list of scientific names of nematodes attacking plants, and their synonymies, is given The symptoms resulting from nematode attack are illustrated by photographs which are generally of a high standard The book should form a useful source of reference to experienced workers as well as a text-book for the student W G INGLIS

Acetophenetidin

A Critical Bibliographic Review By Prof Paul K. Smith (Monographs of the Institute for the Study of Analgesic and Sedative Drugs, No 4) Pp x+180 (New York Interscience Publishers, Inc , London Interscience Publishers, Ltd , 1958) 45s

P K SMITH'S book on acetophenetidin is the fourth in a series of monographs reviewing the literature on individual drugs It deals with 529 references on the clinical uses, pharmacological properties, metabolism and side-effects of acetophenetidin (phenacetin) and its metabolite N-acetyl-*p*-aminophenol The book throws an interesting light on the history of the use of antipyretics, and reflects the changes in medical thought on disease during the past seventy years If the purpose for which the drug is employed has changed, its popularity has stood the test of time, and justifiably so, since acetophenetidin is not only efficacious but virtually free from harmful side-effects Pharmacological work on the substance will continue, as we are far from understanding the reasons for its pain-relieving action MARTHE VOGT

A NEW EXPERIMENTAL TEST OF SPECIAL RELATIVITY

By J. P. CEDARHOLM
I.B.M. Watson Laboratory
AND
Prof. C. H. TOWNES
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EXPERIMENTS which have tested special relativity have usually been forced to rely on great delicacy and precision in order to detect or examine the small differences between predictions of special relativity and those of alternate theories. This is because these differences appear multiplied by a very small quantity $(v/c)^2$, where c is the velocity of light and v is some relative velocity which is generally much smaller than c. While giving a clear-cut support to special relativity over some other theories such as a simple ether, experiments have not generally measured the small terms in $(v/c)^2$ with impressive fractional accuracy. Michelson and Morley's first experiment[1], for example, was of remarkable precision. But it was searching for a change in light-path of only about one part in 10^8 due to the motion of the Earth about the Sun on the basis of the then current ether theory, and was able to set an upper limit no less than 1/40 of this, or an ether drift of about one-sixth the orbital velocity of the Earth. Subsequent very refined experiments[2] of a similar type succeeded, a half-century later, in setting an upper limit on any ether drift of 1/20 the velocity of the Earth around the Sun. Others[3] even suggested the existence of an ether drift as large as about one-fifth of the orbital velocity of the Earth. The advent of very high precision atomic clocks suggests that still more exacting experimental tests may now be made; one such, which is now more or less completed, is reported here.

The experiment compares the frequencies of two maser oscillators[4] with their beams of ammonia molecules pointed in opposite directions, but both parallel to a supposed direction of motion through the ether. If both masers are rotated 180°, and their frequencies again compared, a change in relative frequency should be found due to motion of the masers through the ether, assuming the molecular vibrations are unchanged by such motion. A precision of one part in 10^{12} has been achieved in this frequency comparison, and failure to find a frequency change of the predicted type allows setting the upper limit on an ether drift as low as 1/1,000 of the orbital velocity of the Earth. This precision also provides a test for some other effects which will be discussed below.

The effect on the frequency of a beam-type maser oscillator of motion through the ether was first worked out by Møller[5]. A brief, somewhat intuitive explanation of this shift follows. In this device, ammonia molecules in an excited state travel at thermal velocities along the axis of a circular cylindrical cavity, giving it energy. If the cavity is stationary in the ether, the standing waves may be considered to be made of travelling waves with wave-fronts nearly parallel to the axis. As the molecule moves along the axis, there is then no Doppler shift. If the apparatus is moving axially through the ether at velocity v, the wave-fronts must tilt at an angle $\alpha = v/c$ in order to follow this axial velocity. Hence, molecules travelling at velocity u through the cavity produce a frequency shifted by the Doppler effect of an amount $\nu u\alpha/c = \nu uv/c^2$. Here ν is the molecular frequency. Since $uv\nu/c^2$ depends on the relative direction of u and v, two masers with oppositely directed beams should have frequencies which differ by $2uv\nu/c^2$ due to this effect. If each is rotated 180°, the total change in their frequency difference is $4uv\nu/c^2$.

A more precise derivation of this effect is obtained from the fact that special relativity predicts the same result as does an ether theory, provided that the FitzGerald contraction $\sqrt{\left(1 - \frac{V^2}{c^2}\right)}$ is introduced for any length parallel to the motion v through the ether, and also that the proper time of any clock or oscillator is modified by the same factor $\sqrt{\left(1 - \frac{V^2}{c^2}\right)}$ due to this motion. In other words, any effect due to motion through a simple ether is just compensated by appropriate changes in scale for length and time which correspond to the Lorentz transformation. If, then, an ether theory is used without FitzGerald contraction and time dilation, the expected shift in frequency may be computed from an examination of the effects of these changes of scale for length and time.

Consider first the FitzGerald contraction. Its effect on the frequency of maser oscillation is very small and may be neglected because this frequency is rather insensitive to the dimensions and resonant frequency of the cavity[4].

The time dilation, however, produces the effect we seek. If the cavity moves through the ether at a velocity v and the molecule through the cavity at velocity u, then the molecular velocity through the ether is $V = u+v$, and the molecular time will be slow, for an observer in the framework of the ether, for the factor

$$\sqrt{\left\{1 - \frac{(u+v)^2}{c^2}\right\}} \approx 1 - \frac{u^2}{2c^2} - \frac{uv}{c^2} - \frac{v^2}{c^2}$$

But time in the actual laboratory framework, which is fixed with respect to the cavity, is slow by the factor

$$\sqrt{\left(1 - \frac{v^2}{c^2}\right)} \approx 1 - \frac{v^2}{2c^2}$$

Hence the molecule would appear slow to an observer in the laboratory by the difference between these two, or by the factor

$$1 - \frac{u^2}{2c^2} - \frac{uv}{c^2}$$

The first small correction is the well-known transverse Doppler effect, and is independent of ether drift The second small correction is the discrepancy uv/c^2 which would occur if we were to accept a simple ether and no time dilation in the proper oscillation of the molecule, as postulated in Møller's original discussion[5]

The above derivation makes it clear that failure to see any change in time equivalent to the small fractional amount uv/c^2 may be explained away by the assumption of a time dilation for those who wish to adhere to an ether with such peculiarities Hence the experiment is more closely related to the Kennedy–Thorndike experiment[6] than to that of Michelson and Morley A null result in the latter needs, of course, only a FitzGerald contraction for an explanation in terms of an ether theory

For performance of the present experiment, two ammonia beam masers were mounted with oppositely directed beams on a rack which rotated about a vertical axis The frequencies of these oscillators are near 23,870 Mc /s The thermal velocity $u =$ 0 6 km /s for NH_3 at room temperature If the orbital velocity of the Earth is assumed to be the rate of motion through the ether, then $v = 30$ km /s and the frequency change $4uv\nu/c^2 = 20$ c /s when the masers are rotated 180° from an initial east–west position at noon or midnight

During a small fraction of a second the relative frequency of the two masers fluctuates randomly about $\frac{1}{10}$ c /s Over somewhat longer periods, such as those required for measurement before and after rotation, the average frequency difference does not vary more than about $\frac{1}{50}$ c /s or one part in 10^{12}. Hence the 20 c /s variation expected on an ether theory would be very easily detected Variation of about 1 c /s on rotation of the two masers was in fact observed However, this variation could be eliminated by magnetically shielding the masers, and without shielding it remained constant to within about $\frac{1}{50}$ c /s as the Earth rotated throughout a 24-hr run This shows that no more than about $\frac{1}{50}$ c /s shift could be attributed to an ether drift

The experiment involving rotation of the two masers was carefully done for the first time on September 20, 1958[7] No proper effect as large as $\frac{1}{50}$ c /s was found Hence, since the orbital velocity of the Earth of 30 km /s would have given an effect of 20 c /s , the ether drift could not have been larger than 1/1,000 of this value, or 30 m /s It is, of course, possible for the motion of the Earth to be just cancelled by the motion of the solar system through the ether at some particular time of the year The experiment has now been repeated at the Watson Laboratory during 24-hr runs at approximately three-month intervals throughout the year In none of these runs was any effect as large as $\frac{1}{50}$ c /s found

The present experiment sets an upper limit on an ether-drift velocity about one-fiftieth that allowed by previous experiments This is in part because the effect measured is linear in the ether drift velocity v An experiment of the Michelson–Morley type is designed to detect a fractional change of the form $\frac{1}{2}v^2/c^2$, which is an order of magnitude larger than the term uv/c^2 discussed here An upper limit of 1/400 of $\frac{1}{2}v^2c^2$ has been set by the very careful experiments of Joos[2] with a Michelson interferometer However, since this term is second order in v, the upper limit given for the ether-drift velocity is one-twentieth of the orbital velocity of the Earth, or 1 5 km /s The present experiments have the advantage that the expected effect is linear in v, and also that two clocks can now be compared with much greater precision than can two distances This experiment, involving a comparison of two maser oscillators to an accuracy of one part in 10^{12}, may perhaps represent the most precise experiment so far reported

For most physicists, a confirmation of the fundamental postulate of special relativity that no absolute motion can be detected comes as no surprise, and a more precise experimental test may not even seem important because this postulate is so intuitively satisfactory and firmly accepted It should be noted, however, that the positive detection of an effect in the present experiment could give some new information without necessarily contradicting the general principles of relativity The motion of the Earth involves velocity relative to other parts of the solar system, as well as to the fixed stars and external galaxies Hence this relative motion might, in principle, produce some anisotropy in space and some shift in relative frequency of the two masers when they are rotated by 180°

Dicke[8] has suggested that an effect due to motion with respect to fixed masses in the universe should be present which is of the order of the fine structure constant, α, times the effect due to ether drift This would correspond to a frequency shift in the present experiment of the order of $\frac{1}{7}$ c /s Reasons given by Dicke why such a shift might occur are speculative, but very interesting The present results allow no shift larger than $\frac{1}{50}$ c /s , which gives some indication against a term of the order $4\alpha uv\nu/c^2$

Optical maser oscillators[9] should also lend themselves to interesting experiments on relativity, since they will probably be capable of examining changes in length as small as one part in 10^{12} An optical maser oscillator could be constructed with a resonance between two étalon plates which is narrower in frequency than the atomic resonance supplying energy In this case the frequency would depend primarily on the spacing between the plates, rather than on the atomic frequency It is estimated that the oscillation would be monochromatic to about one part in 10^{11} This suggests an experiment in which the oscillations of two optical masers are beat together in a photocell One of the masers may be rotated about a vertical axis On the basis of an ether theory, the beat frequency should then vary by an amount $\pm\ v^2\nu/2c^2$, for the same reasons that the Michelson–Morley experiment was expected to show a variation of path length The fraction v^2/c^2 is 10^{-8}, so that its presence could probably be tested with excellent precision

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ECHO-LOCATION AMONG *COLLOCALIA*

By LORD MEDWAY

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IT is known that a number of species of the swiftlets (*Collocalia*) of south-east Asia are able to fly in total darkness in the caves in which they nest. When on the wing in the dark or in poor light they utter a series of click-like calls in very rapid succession so that the final effect is a staccato rattle. Novick[1] has recently demonstrated that this call is essential for oriented flight in darkness by *Collocalia brevirostris unicolor*, a swiftlet found in Ceylon.

A similar call is heard from *Collocalia maxima lowi*[2], which nests in a number of caves in Sarawak[3]. In 1957, recordings of this swiftlet were made for the Sarawak Museum with the assistance of staff of Radio Sarawak. Successful recordings were made both under natural conditions in Meraja cave, Bau[4], known to be inhabited only by *C. maxima*, and of individuals of the same species flying singly in the dark-room of the Sarawak Museum, which measures 11 ft. by 16 ft. by 12 ft. high and has interior walls finished in rough plaster and distemper.

The recording apparatus used was a Philips hand microphone type 9564/10 with an E.M.I. portable battery-operated recorder, type *L2B*. Parts of the tape were later played into the 'Sonograph' sound spectrograph to give a plot of frequency spectrum against time. They were also played back into an oscillograph which was photographed on moving film. From these films the spectrum was calculated by carrying out a Fourier transform of the wave-form.

Although blindfolding and deafening experiments were not performed, there are several features of the rattle call of this swiftlet that emphasize its function in dark orientation; many of those listed below are discernible on the tape recording. (Copies of the edited tape, with commentary, are held in Kuching, at Cambridge and by myself.)

(1) Birds approaching the cave from outside are heard rattling while still some distance from the mouth, but those leaving the cave by day in direct flight are silent well within it when in sight of the mouth. This has already been noted and discussed by Novick (*op. cit.*). By night, however, outgoing birds continue to rattle beyond the mouth.

(2) In imperfect darkness the rattle is not continuous but intermittent; clearly its use is not obligatory and, for example, in the dim light near the cave mouth, it is employed only in dark corners where eyesight fails.

(3) In complete darkness the rattle is continuous, although it tends still to be somewhat spasmodic when the bird is on a familiar flight line through a large chamber. The highest rate of steady rattle recorded on the tape is six clicks per sec., but when a bird approaches its nest site, or if it is frightened in the dark, the rate may be higher still.

(4) In dark regions of the cave away from the nest sites, where all birds are in passage to or from the mouth, only the rattle call is heard and never song or other vocalization; apparently the two types of call cannot be uttered simultaneously. This suggests that the mechanism is syringeal; however, the rattle sound is so unlike any other call that a different mechanism may be involved.

(5) Roosting or nesting birds do not utter the rattle call; a bird flushed from the nest is silent for the first yard or two of flight. For this reason attempts to record at the nest sites were unsuccessful.

(6) The rattle call appears late in development, and well-grown fledglings which are forced to fly prematurely often do so silently, and are then totally disorientated in darkness.

In the Museum dark-room, five birds were flown singly. In every case the rattle call was 'switched on' the instant the electric light was switched off; when the light was turned on again it ceased less abruptly, tending to die away slowly into short well-spaced bursts or single clicks. Such brief outbreaks of rattle are heard in the field from swiftlets flying near cliffs or mountain tops, or diving to drink (on the wing) from the rivers. Chasen[5], in an account of weather movements of mixed swift and swiftlet flocks in Malaya, records the rattle call far from any cave.

In caves the rattle is never heard from birds at roost and usually ceases the moment they alight on the nest; but occasional clicks or brief outbreaks of rattle were heard from the caged swiftlets in transit from Meraja cave to the Museum. It seems likely that in unfamiliar surroundings or when close to solid (or liquid) surfaces the rattle call may be used tentatively to supplement eyesight even in full daylight.

Analysis was applied to three recordings: a single bird flying in the cave, a single bird flying in the dark-room, and very many birds rattling simul-

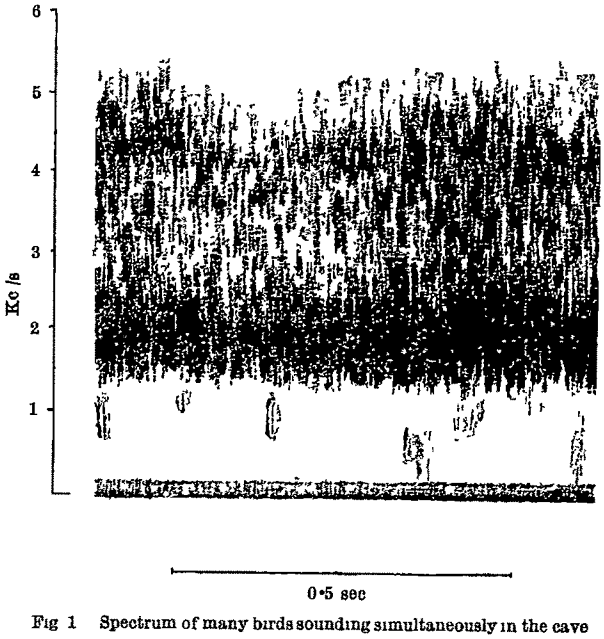

Fig. 1. Spectrum of many birds sounding simultaneously in the cave

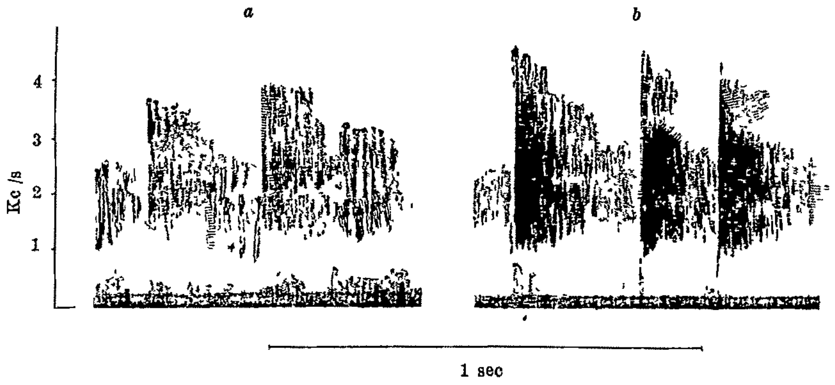

Fig 2, a and b Two different birds recorded separately in the museum dark-room

taneously in the cave mouth by night Results show that the single click is very brief, lasting approximately 2 5 msec The spectrum of the crowd of birds sounding together is continuous from 1 5 to 5 5 kc /s , with peaks at around 2 and 4 5 kc /s (Fig 1) Isolated bursts of sound from individual swiftlets all fall within the same frequency-range (Fig 2), and successive clicks are more or less similar although they show no exact correspondence of wave form The Fourier analyses of the wave-forms correspond well with the sound spectrograms The single clicks of different birds (Fig 2*a* and *b*), however, show different distributions of frequency peaks within the characteristic range , this variation might assist each bird to identify the echo of its own call among a crowd, although in most circumstances the coincidence in timing between emission and echo would be quite sufficient to discriminate against the calls of other birds For example, it can be shown that if the bird neglects all echoes returning more than 10 msec after emission (that is, reflected from more than 5 ft away) it may be able to infer the presence of an obstacle with 90 per cent certainty, even though there may be twenty other birds within a radius of 20 ft This calculation assumes that the echoes from only three successive clicks are noted , if a greater number can be utilized the discrimination increases correspondingly

The only other avian genus known to echo-navigate is the oil-bird, *Steatornis*[6] This utters a similar call , but the mean frequency is considerably higher (7 3 kc /s) and the range (6–10 kc /s) does not overlap with that of *Collocalia maxima*, which is shown to rely for sonic-navigation on lower frequencies than any other bird, bat or dolphin so far investigated Other *Collocalia* in Sarawak also utter the same call , one species (*C esculenta*) lacks it As part of a survey of the life and habits of the genus in Borneo at present in hand, it is hoped soon to extend investigation of the use of echo-navigation and of the physiology of the mechanism involved

I am grateful to Mr Tom Harrisson, curator of the Sarawak Museum, for the opportunity to work in Sarawak, for encouragement in the study of *Collocalia* and for criticism of this communication before publication, to the staff of Radio Sarawak, whose interest and help made these recordings possible , and to Dr K E Machin, of the Department of Zoology, Cambridge, for the analysis of the recordings and for the discussion on the identification of a bird's own call

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IONIZATION PHENOMENA IN GASES

THE fourth International Conference on Ionization Phenomena in Gases took place at Uppsala, Sweden, during August 17–21 The very wide programme included sections on plasma physics, as well as on fundamental processes and other applications of electric discharges, and attracted a representative gathering of about 800 scientists from research organizations active in this field in twenty-five different countries This number of delegates represented a considerable increase when compared with the previous Conference at Venice in 1957, and reflects the increasing world interest in this subject After a short opening address by the honorary president, the Rector Magnificus of the University of Uppsala, Prof Torgny Segerstedt, the general pattern of the Conference followed closely that of previous conferences in the series[1], in that part of each day was devoted to plenary sessions, at which general survey papers were read, while for the rest of the time the Conference split into four parallel sessions taking place simultaneously The titles of these sessions were (1) Fundamental Processes , (2) Different Types of Discharges and Their Application , (3) Theoretical and Experimental Studies in Plasma Physics , and (4) Production, Confinement and Heating of Plasmas Since there were, altogether, about 250 papers presented, considerations of space make it impossible to give a complete coverage in this report , instead, a selective review of the papers given in the plenary session together with those in the related sessions which can be regarded as having the most general interest is given, but this inevitably means the omission of mention of many papers

Fundamental Processes

W L Fite (San Diego) presented a paper surveying recent advances in the study of collision processes in gases, in which he first discussed the results obtained for the cross-section for scattering and electron exchange using modulated crossed-beam techniques, work with which he himself has been associated for a number of years Further work on the determination of inelastic collision cross-sections using the trapped electron method was then discussed, and the paper concluded with a review of recent results on heavy-particle collisions using an extension of the modulated cross-beam techniques This particular aspect of the work was discussed in more detail by the same author in a later paper given in Section 1, results being given for cross-sections of charge transfer and ionization for H^+ and H_2^+, and for charge transfer and electron stripping for H^- in H within a range of ion energies from 50 eV to 50 keV Other experiments using crossed beams were described by R L F Boyd and A Boksenberg (London), who reported on measurements of ionization cross-section of electrons in H together with a trochoidal mass spectrometer analysis of the ions produced The trapped electron method was also described in detail in a later paper by G J Schulz (Pittsburgh), who showed that using this method it is possible to study the shape of an excitation function from its onset to 3 eV above onset An interesting result obtained in these experiments was that there is a large inelastic peak in nitrogen and carbon monoxide at 2 3 eV and 1 7 eV respectively , the formation and subsequent decay of temporary negative-ion states of nitrogen and carbon monoxide was put forward in explanation of these results

Several papers were presented on the measurements and calculation of collision cross-sections for particles of high energies up to 200 keV Particularly active in this field are the members of the Physico Technical Institute of the Academy of Science of the U S S R , who presented three papers (two of which were read by N V Fedorenko and the other by V M Dukelsky), giving the results of measurement on electron-capture by multiply charged ions, on the ionization of inert gases by protons, and on the ionization of high-velocity alkali atoms by collisions with atoms of inert gases The results of recent measurements on the growth of pre-breakdown ionization currents for several organic vapours were reported by A E D Heylen (London), and for air by A N Prasad and J D Craggs (Liverpool) and by J Dutton, F Llewellyn-Jones and R W Palmer (Swansea) , in the latter two papers the influence of attachment on the growth of ionization was also assessed A technique for the measurement of attachment coefficients for very low-energy (nearly thermal) electrons in oxygen and nitrogen was described by M A Biondi (Pittsburgh) and the results analysed in terms of two- and three-body collisions Other papers concerned with ionization coefficients were those of J M Meek (Liverpool), who put forward the proposal that the decrease in secondary ionization with increasing concentration of water vapour in air is due to a reduction of the photo-electric emission consequent on the absorption of photons by the water vapour, and of D E Davies, J G C Milne and J Myatt (Keele), who discussed the influence of gas purity, tube geometry and method of calculation on the determination of ionization coefficients in hydrogen and the inert gases

Another survey paper dealing with fundamental processes was given at one of the plenary sessions by G L Weissler (Los Angeles), who described the techniques used to study the interaction of the vacuum ultra-violet photons ($h\nu = 7$ to 30 eV) with gases Of particular interest were the results obtained using mass spectrometer techniques for identification of the ions in the determination of specific photo-ionization cross-sections, and of ion molecular reaction rates for such complex ions as N_2H^+ It was shown that with equal concentration of nitrogen and hydrogen the number of N_2H^+ ions produced per unit light intensity increased with increasing energy of the irradiating photons throughout the range investigated, whereas the number of H_2^+ ions showed a peak within this range Further studies of the interaction of photons with gases were described in papers by D K Davies and F Llewellyn-Jones (Swansea), who discussed the influence of collisions of the second kind between excited and neutral molecules, on secondary ionization in hydrogen, and by A Przybylski (Hamburg), who reported measurements of the absorption coefficients in oxygen and nitrogen of gas-ionizing radiation produced by corona discharges in the same gases The complex structure of the optical excitation functions revealed in experiments with mercury and helium were described by H M Jongerius (Utrecht) in a joint paper with C Smit and J A Smit, and theoretical calculation of the 1*s*–2*p* electron excitation cross-section of atomic hydrogen was reported by A Kingston, B L Moiseiwitsch and B Skinner (Belfast)

Another topic surveyed in a paper at one of the plenary sessions was that of recent work on the study of current growth and on avalanches of large amplification, by H Raether (Hamburg) The techniques developed at Hamburg for the study of single electron avalanches in gases such as methane (where large amplifications can occur during the first electron transit time) were described It was reported that the probability of these large avalanches leading to *kanal* breakdown increased with the number of carriers (electrons) in the avalanche The statistical nature of such avalanches was discussed, and in a later paper H Schlumbohm (Hamburg) described in detail the way in which the primary ionization coefficient may be obtained from measurements of avalanche statistics, and gave results for various organic vapours Another member of the same group, L Frommhold, presented results of measurement of the drift velocity and mean energy of agitation of electrons, obtained by studying the electron component of electron avalanches Raether concluded his paper by discussing the growth of ionization in the case where there is a relatively strong external illumination of the cathode, which makes statistical variations of avalanche size relatively unimportant Experimental results for temporal growth of ionization under these conditions were given by F Llewellyn-Jones and E Jones (Swansea), who showed the importance of the stability of the cathode surface in such investigations which involve accurate measurements of formative time lags, and how the magnitude of the individual secondary ionization coefficients in hydrogen and hence the growth times depend on the state of the cathode surface Another paper on the effect of the state of the cathode on growth times and sparking potentials in hydrogen was given by B J Hopkins (Keele) in a paper with D E Davies, R K Fitch and C F Gozna Breakdown potential measurements for the interesting region below the Paschen minimum and for a c fields were described and discussed by H Niesters and L Graf (Aachen), respectively The way in which space charge influences the current growth to give the observed voltage-current density characteristics was investigated in a paper by A L Ward and M J Reddan (Washington)

The remaining papers under this heading were mainly devoted to problems associated with the bombardment of surfaces by ions and with the consequent sputtering

Arc, Spark and Glow Discharges

Discussing recent progress in arc research in a paper to one of the plenary sessions, W Lochte-Holtgreven (Kiel) first described results of mass spectrographic analyses of heavy ions (produced, for example, from pumping oil) in electro-magnetically compressed arcs, showing that a resolution of 1 part in 4,000 is attainable

The way in which radiation from arc discharges has been analysed to determine the contribution due to the formation of negative ions was outlined, and it was shown that this process contributed in very large measure to the total radiation in oxygen Similar studies in nitrogen have demonstrated the existence of a metastable negative ion of nitrogen with a short life-time of about 10^{-6} to 10^{-7} sec , which is consequently not detectable by the usual mass spectroscopic techniques , this result is in agreement with the results of Schulz mentioned above

Also discussed were chemical processes occurring in arc discharges, and the use of arc discharges in the separation of isotopes of neon, and of neon and nitrogen by thermal diffusion techniques

Experimental and theoretical studies on the decay of interrupted arcs were discussed in papers by H Edels and by D Whittaker (Liverpool), respectively It was shown experimentally that the initial decay of gas temperature during the first 500 μsec is of the order of 1 7° K per μsec from an initial value of 7,200° K , the full recovery taking approximately 1 sec The theoretical treatment proceeded by first determining the steady-state radial distribution for a specified current and field strength and then calculating changes in that distribution as a function of time, using the variation of thermal conductivity, specific heat and gas density with temperature A paper on the re-ignition of a c arcs was given by W Rieder and H Schneider (Vienna), who discussed the measurement, by calorimetric means, of the cooling effect of the electrodes , and put forward an explanation for the sudden step in the re-ignition voltage in the recovery curves for low-current arcs, in terms of the disappearance of electrons from the gap The post-arc behaviour of two practical circuit breakers was discussed in a paper by V K Bisht, G A W Rutgers and D Th J ter Horst (Arnhem) in which measurements on the effect of pressure and rate of rise of re-striking voltage on the value of the post-arc current were reported

The behaviour of argon arcs in axial magnetic fields was discussed in a paper by M. McChesney, P C McNeill and J J Matthews (Rugby), who gave an account of spectroscopic, rotating mirror and voltage-current measurements Arcs in transverse magnetic fields were the subject of a paper by P E Secker (London), who reported investigations of the effect of the cathode surface on arcs moving in the Amperian direction ; experiments on the Amperian and retrograde motion of arcs in a magnetic field inclined to the plane of the cathode were reported in a paper by A E Robson (Harwell)

Sparks in long gaps were discussed in two papers by R T Waters and R E Jones, members of the Associated Electrical Industries, Aldermaston The first paper described how the impulse breakdown of long inhomogeneous field gaps was studied by means of time lag measurements, and how attempts to explain these measurements were made by correlation with field distortion produced by space charge created in the gap by the initial corona bursts In the second paper a different technique for studying the same problems was described This technique involved pulse chopping and high-speed photography to measure the growth times of leader channels to within ± 0 05 μsec The step-lengths of the spark leaders so measured were discussed in relation to the Schonland theory of lightning stepping An analysis of the relation between lightning discharges and whistlers was given in a paper by H Norinder (Uppsala)

Striations in the positive column of glow discharges were discussed in papers by M Klerk (Eindhoven), who described measurement on d c and high-frequency discharges in tubes of various geometries, by W Schallreuter (Greifswald), who investigated the dependence of frequency, wave-length and velocity of moving striations on various discharge parameters, and by A Rutscher of the same laboratory, who described investigations of spectral emission from moving striations in neon glow discharges A theoretical discussion of the positive column of low-pressure mercury-rare gas discharges, using the cross-section curves for excitation and ionization of mercury, the Ramsauer cross-section curves of the rare gases and taking into account the imprisonment of the resonance radiation was given by M A Cayless (Rugby) D Muller-Hillebrand (Uppsala) described investigations of the conditions under which hydrogen–air and propane–air mixtures can be ignited by corona discharges, and concluded that discharges from points with currents up to 100 μamp do not ignite gas–air mixtures, whereas discharges from rounded objects can ignite at an effective current of less than 5 μamp A paper by J S T Looms (Leatherhead) described investigations to assess the importance of corona as a source of interference with micro-wave communication It was found that even when d c powers as great as 60 watts were developed in discharge systems 15 cm in length, no noise output greater than 1 per cent of that of an argon noise reference source was observed From this and other results it was concluded that d c corona is not a serious source of interference in the X-band

Many of the remaining papers in this section were concerned with the mechanism of Geiger-counter discharges, a subject which still provokes attention

Plasma Physics

In reviewing that section of the Conference devoted to plasma physics, main attention must be directed to the plenary session on recent results from research on controlled thermonuclear reactions

The session opened with a series of papers from the United States , J L Tuck (Los Alamos) first discussed recent work on *Scylla* and stated that it was believed that neutrons obtained from this device were truly thermonuclear He also discussed the difficulties inherent in research on controlled thermonuclear reactions due to the onset of cyclotron resonance, and described a new machine, known as *Picket Fence*, having a four-cusped magnetic field configuration, which, it was hoped, would succeed in overcoming the problems created by cyclotron resonance Other work on *Scylla* and on a rotating plasma containment device called *Ixion* had earlier been presented by F L Ribe (Los Alamos), in which measurements of the diamagnetism of the plasma during its acceleration and after removal of the radial electric field were discussed.

R. F. Post (Livermore) reviewed recent progress on mirror machines where investigations have been concerned primarily with (*a*) studies of injection methods, (*b*) investigation of diffusion and non-adiabatic loss processes, and (*c*) further attempts to analyse the energy spectrum of trapped and heated plasma particles. The experimental difficulties being encountered at this stage in the project were outlined. Results were given of measurements of the radial distribution and rate of diffusion loss of the high-energy electron component of a heated plasma, produced by magnetic compression.

The present state of the *DCX* experiment was reported by A. H. Snell (Oak Ridge) and difficulties being encountered in providing a suitably energetic injection system were analysed. The paper discussed, among other things, observations on the spreading of the trapped ions, life-times of trapped particles, the density of the trapped plasma and an assessment of the factors that may be limiting this density. Another, earlier paper by J. S. Luce (Oak Ridge) had discussed in more detail the trapping of high-energy ions within the walls of a hollow vacuum arc. This wall prevents neutral atoms from reaching the trapped ions and therefore reduces charge exchange losses. New arc techniques were described which include plans for 15 in. diameter discharges.

Contributions from the United Kingdom were presented by G. Francis (Harwell), G. B. F. Niblett (Atomic Weapons Research Establishment, Aldermaston) and D. R. Chick (Associated Electrical Industries, Aldermaston). Progress reported from Harwell included the recent identification of Alfvén waves in a high-current toroidal discharge; an earlier paper by D. F. Jephcott (Harwell) had discussed measurements of the velocity and damping of these waves. Other fields of investigation have included experiments with linear pinch and inverse pinch systems (which have shown that in the inverse pinch case the current sheath remains stable for a longer time than in the straightforward pinch system) and some further work on *Zeta*.

Much of the work on devices such as the thetatron (azimuthal current) carried out at the Atomic Weapons Research Establishment, Aldermaston, had been reported in other papers, so that the review by G. B. F. Niblett was confined to a discussion of attempts to produce very large rates of current growth, by the design of very low inductance systems, and some very recent studies of dissociation phenomena in the hydrogen molecule. Rates of current rise of 6×10^{12} amp./sec., with peak currents of 3×10^{6} amp., were reported for the parallel spark gap condenser bank known as *Maggie*. Again, because of many earlier papers from other members of the A.E.I. team, the review by D. R. Chick was confined to a description of the design and engineering of the machine to be known as *Sceptre IV*, and an outline of the proposed experimental programme.

Although members of the U.S.S.R. delegation delivered papers during this plenary session, there were no review papers in the sense of those presented by the United States and the United Kingdom. Because of this, the papers from the U.S.S.R. will be discussed in those sections of this report to which they were directly related. Two other papers concerned with thermonuclear investigations were presented in plenary sessions. W. B. Thompson (Harwell) considered fine-scale magneto-hydrodynamic behaviour in plasmas, where the effects of the finite ion Larmor radius may be important, by use of the collision-free Boltzmann equation. A consistent series expansion of this equation was used to derive first-order magneto-hydrodynamics, and the magneto-hydrodynamic shock was studied as an application of this technique. "Recent Progress in Shock Wave Research" was the title of a paper by A. C. Kolb (Washington), and in it he described the spectroscopic study of temperature and density in shock-wave fronts. Very high-ionization densities had been achieved and there was strong evidence for high temperatures, and thus considerable ionization, ahead of the travelling wave-front, probably produced by a radiation process. In the general paper sessions, those concerned with plasma physics were divided into two: (*a*) theoretical and experimental studies in plasma physics, and (*b*) production, confinement and heating of plasmas. These two sections will be briefly reviewed individually.

Theoretical and Experimental Studies in Plasma Physics

The topics in this section were transport phenomena, interactions involving electric and magnetic fields, micro-wave radiation measurements and spectra from plasmas.

An interesting theoretical approach to transport phenomena was described in a paper by M. N. Rosenbluth and N. Rostoker (San Diego), where, in a fully ionized plasma, all field particles are considered to be in equilibrium except for one 'test' particle. The resultant reaction on this test particle, due to its interaction with the field particles, consists of a frictional drag and a random force that produces acceleration and diffusion in velocity space. A systematic procedure for determining these effects with no magnetic field and in the presence of a constant magnetic field has been developed.

The topic "Interaction involving Electric and Magnetic Fields" produced the largest number of papers of any at the Conference. Among them was a paper by Dermikhanov, Gevarkov and Popov (Moscow) on "The Interaction of a Beam of Charged Particles with a Plasma". This paper described the investigation of plasma oscillations created by a continuously injected electron beam. It was shown that the maximum intensity of plasma oscillation is produced when the electron beam passes through the plasma. Electromagnetic fields with the same plasma frequencies were also found outside the plasma column; the intensity of these oscillations as a function of the density of the plasma was investigated and found to be the same as that inside the plasma column. Detection of these oscillations was possible because of the considerably increased sensitivity of the recording apparatus compared with that used by previous workers. Another paper on this topic was that by Khazchenko and others (Moscow); in this case an electron beam was modulated by oscillations in a plasma through which it passed and afterwards detected in a resonant cavity.

Other papers of interest included one by J. A. Wesson (Associated Electrical Industries, Aldermaston) on the effect of runaway electrons on the heating of a plasma, where it was shown that, for constant electric field, runaway electrons set a limit to the temperature which can be efficiently achieved by ohmic heating, but for constant current density, if the fraction of the current carried by the runaways is small, this fraction will decrease as the temperature increases A paper by I B Bernstein and I N Rabinowitz (Princeton) considered the velocity distribution of plasma electrons in an external magnetic field when the ions are assumed to be infinitely massive, and electron–electron interaction is suppressed These assumptions produced equations which could be solved numerically on a computer, and results indicated that, with an initially Maxwellian distribution, the distribution functions do not develop the double-humped character which oscillation theory indicates to be unstable

J E Allen and F Magistrelli (Rome) described experiments on the plasma sheath transition in the presence of a magnetic field Using an azimuthal magnetic field which could be applied in the 'pinch' or 'anti-pinch' direction, they showed that a magnetic field in the pinch direction reduced the directed energy of the positive ions leaving the plasma and a magnetic field in the anti-pinch direction increased this energy The result was shown to be in accord with theoretical predictions

S C Brown (Massachusetts) in his review paper on "High Frequency Waves in Ionized Gases" considered the various types of electromagnetic waves that are set up in an ionized gas due to the application of a magnetic field There are six natural frequencies, three being cyclotron frequencies and three plasma frequencies Because the magnetic field is a vector the resultant oscillations in the plasma can be parallel or perpendicular to the field and thus a very large range of possible oscillations exists The paper discussed some basic properties of these waves

A fascinating combination of plasma and microwave physics was presented in a paper by G S Kino and B Ludovici (Stanford) The paper discussed a plasma parametric amplifier based on the principle that if electromagnetic waves of three frequencies ω, ω_1 and ω_2 such that $\omega = \omega_1 + \omega_2$ can be propagated through a loss-less non-linear medium with propagation constants β, β_1, β_2, strong interactions will take place between these signals if $\beta \approx \beta_1 + \beta_2$, if ω is of large amplitude there will be a power transfer to ω_1 and ω_2 This principle has been confirmed in a mercury vapour d c discharge with $\omega = 800$ Mc /s, $\omega_1 = 500$ Mc /s, and $\omega_2 = 300$ Mc /s Both ω_1 and ω_2 have been observed to increase in amplitude by a few db in travelling from one end of the positive column to the other

The broadening of spectral lines by Stark effects was discussed by H Margenau (Yale) Equations for the calculation of half-widths were given for three different cases (i) when both electrons and ions can be treated by impact theory, (ii) when the electrons can be treated by impact theory but the ions have to be considered statistically, and (iii) when both electrons and ions can be treated statistically Physical conditions to which these equations are applicable were discussed Improved methods of calculating Stark broadening of spectral lines were presented in a paper by H R Griem (Maryland) and A C Kolb (Washington) It was shown that the calculated line profiles depend only slightly on temperature and can therefore be used to deduce electron densities in dense plasmas from measured profiles with much improved accuracy

Production, Confinement and Heating of Plasmas

This section, as with the other sections of the Conference, was split into sub-sections which were: (a) the longitudinal pinch, (b) mirror machines and the azimuthal pinch; (c) shock waves, and (d) further methods of production and confinement

In a paper by D W Allan (London), consideration was given to the detailed behaviour of the simple unstabilized pinch in respect of the inward movement of the current sheet He concluded that evidence favours the free-particle piston model and the shock-wave model rather than the snow-plough model Whether the behaviour follows more closely the free-particle model or the shock-wave model depends on the effective mean free path

Two papers by S A Colgate, H P Furth and others (Livermore) discussed the linear and toroidal hard-core or inverse pinch Small-scale instabilities in the linear case have been shown to be of non-hydromagnetic origin A toroidal version of the hard-core pinch has been attempted using a magnetic field to levitate a ring conductor inside a toroidal shell This device will be used to study the nature of these small-scale instabilities and also to study the stability of near-vacuum field hard-core configurations and to determine if this stability leads to an improved containment of the plasma energy "A Dynamically Stable Current Column" was the title of a paper by V S Komelkov and others (Moscow) The formation and development of a current cord appearing during the movement of a plasma jet were examined by means of advanced high-speed photographic techniques Measurements were made of the current distribution in the moving plasma jet and showed that the current in the cord had remained stable throughout the half-period of the discharge The existence of a radiation continuum the appearance of which coincided with the appearance of the current cord had also been demonstrated

A Kantrowitz and others presented a paper on the use of collision-free shocks to study dissipation mechanisms in collision-free plasmas At high temperatures, collisional dissipation in plasmas is slow, and losses due to magneto-hydrodynamic turbulence become important Preliminary experiments show that it is possible to produce shock waves that obey the required theoretical condition that the shock thickness is less than the mean free path, and that observations on these thin shocks can provide a powerful tool for the study of dissipative mechanisms in collision-free plasmas

Finally, L Hogberg, K Siegbahn and K Bockasten (Uppsala) described an apparatus for the electrodeless generation and acceleration of plasma rings A single-turn primary winding placed close to the end wall of a 'Pyrex' tube induces a ring discharge which is accelerated as a function of the gas current and the magnetic field Ion velocities in the range 10^6–10^7 cm /sec have been observed with this technique

Conclusion

During the Conference, visits to the Institute of Physics and the Institute of High Tension Research at Uppsala and the Nobel Institute of Physics in Stockholm were organized, a full social programme for members and their wives was also arranged All those concerned with the organization of the conference and particularly the hard-working secretary, Dr Åke Nilsson, of the Institute of Physics, Uppsala, are to be congratulated on the excellence of the arrangements which enabled such a large conference to run so smoothly thoughout

It is no reflexion on this organization to comment that these conferences, including as they do such a wide range of topics, are becoming too large and unwieldy , one possible solution would seem to be to divide the subject-matter into two groups, one devoted to ionization phenomena and gas discharges and the other to controlled thermonuclear research and plasmas If these groups were arranged to run consecutively it would give those with interest in both fields an opportunity to attend more of the lectures in which they are interested, while considerably reducing the total number of delegates present at any given time

The next conference in this series is to be held in Germany, probably at Baden-Baden, during 1961

J Dutton
D Harcombe
E Jones

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[1] Garton, W R S , and Latham, R , *Nature*, **180**, 790 (1957)

RADIO ECHO OBSERVATIONS OF VENUS

By J. V EVANS and G N. TAYLOR
Jodrell Bank Experimental Station, University of Manchester

DURING September 1959 an attempt was made to observe radio echoes from the planet Venus using the 250-ft radio telescope at Jodrell Bank The radar equipment used with the telescope operated on a frequency of 408 00 Mc /s The transmitted power was 50 kW , pulse-length 30 msec and pulse repetition rate 1 per sec The receiver had a noise figure of 4 6 db and a bandwidth of 60 c p s The overall losses in the feeders amounted to 2 5 db , and the polarization of the transmitted wave was right circular Observations were made with the telescope in continuous motion to follow the planet across the sky, with alternate periods of transmitting and receiving The length of these periods was approximately equal to the time of travel of the radio pulse to and from the planet (5–6½ min)

No echoes were observed with this equipment stronger than the noise-level in the receiver An analysis of the signals for echoes which were weaker than the noise was made with an integrating equipment, which added together receiver noise powers corresponding to the same range-intervals on successive sweeps of the time-base With this system eight adjacent range-intervals were examined These were made equal in width to the transmitter pulse (30 msec) and their distance along the time-base was controlled in order to compensate for the change in range of Venus, so that any echo would remain in the same 30 msec time-interval It was also necessary to provide compensation for the Doppler shift of the echo relative to the transmitter frequency

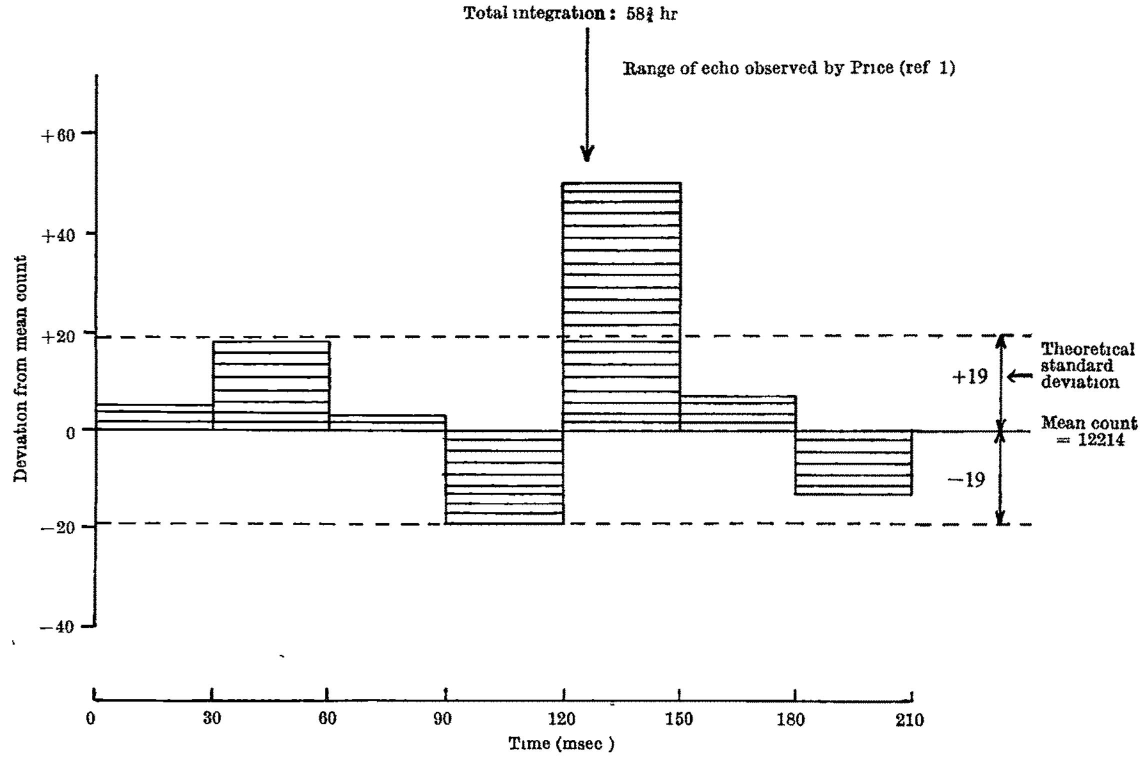

Fig. 1 The deviations of the counters in the integrator system from their mean is plotted as a histogram Different positions of the eight gates along the time base were employed and only seven range-intervals were common to all the periods of observation Hence there are only seven counts shown in the histogram

Exhaustive checks were made to confirm that the integrated noise counts in the eight range channels showed statistical fluctuations which agreed with theory, and that no systematic errors were introduced by, for example, the operation of the transmitter or the telescope Such systematic errors were unlikely because the transmitter and receiver operated alternately for 5–6 min intervals

A total of 58¾ hr useful operating time was obtained before the range of Venus had increased to a point where further work was not considered worth while The addition of all the periods of observation is presented as a histogram (Fig 1) where one of the eight range-intervals shows an excess count of 2½ times the standard deviation The addition of many samples of noise by the integrating equipment gives a Gaussian distribution of counts, hence there is an 8 per cent chance that noise alone will produce a count 2½ standard deviations greater than the mean in one of eight channels If the high count is caused by the planetary echo, then the range observed gives a value for the solar parallax of 8 8020 ± 0 0005 sec of arc This value is in agreement with that obtained by Price *et al* [1] using the Millstone Hill Radar Station operated by Lincoln Laboratory of the Massachusetts Institute of Technology (8 8022 ± 0 0001 sec of arc) The likelihood that, by coincidence, a high count should appear in the range interval predicted by the Millstone Hill result is 1 per cent

The signal-to-noise ratio required to produce an excess count of 2½ standard deviations has been estimated by applying to the receiver signals which are weaker than the noise by a known amount, and is −23 ± 2 db This is within 6 ± 2 db of that expected on the basis of a model for Venus in which it was assumed that the scattering is similar to that observed for the Moon[2] and that the period of rotation is of the order of 20 days However, the result is not in agreement with the work reported by Price, which suggested that the radar cross-section of Venus was equal to the physical area presented by its disk If this were the case a signal-to-noise ratio of about −5 db should have been observed This discrepancy of 18 db in signal strength might be accounted for in two ways (*a*) if the rotation period of Venus is much faster than once every 20 days the Doppler broadening of the echo will cause some of the received power to fall outside the 60 c p s bandwidth limit of the receiver , (*b*) if the echo is subject to large rapid changes in intensity then because a square law detection system was employed at Millstone Hill, a false estimate of the average signal-to-noise ratio would be obtained Such fading could not have been caused by Faraday rotation in the Earth's ionosphere because circularly polarized radio waves were used in both experiments

We are indebted to our colleagues at Millstone Hill for their interest and co-operation, particularly in producing for us predictions of the range and Doppler corrections which were applied to select the received signal

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[1] Price, R , Green, P E , jun , Goblick, T J , Kingston R H , Kraft, L G , jun , Pettengill, G H , Silver, R , and Smith, W B , *Science*, 129, 751 (1959)

[2] Evans, J V , *Proc Phys Soc* , B, **70**, 1105 (1957)

OBITUARIES

Prof. M Caffrey

THROUGH the death of Prof M Caffrey, which occurred on September 17 at the age of seventy, Ireland has lost an outstanding personality in the field of agricultural science and one who took an active part in the Faculty of Agriculture in the National University of Ireland

Michael Caffrey was born at Lughill, near Monasterevan, Co Kildare He received his early education at the local national school and at the Christian Brothers' School, Monasterevan He entered the Albert Agricultural College, Glasnevin, in 1908, and in the following year was awarded an agricultural scholarship into the Royal College of Science, Dublin After a distinguished undergraduate course, he gained the diploma of the latter institution in 1912, and was appointed as assistant to Dr H Hunter in the Plant Breeding Section of the Department of Agriculture, Dublin The studies and work he then undertook under the able guidance of Dr Hunter formed the basis of his later successful career in plant breeding, lecturing and teaching When Dr Hunter resigned after the First World War, Caffrey became head of the Plant Breeding Section of the Department of Agriculture, and when a Faculty of Agriculture was established in the National University of Ireland in 1927, the University made him lecturer in plant breeding, and afterwards in 1938 appointed him to fill the newly established chair of plant breeding, a post which he occupied until his death

Throughout his career, Prof Caffrey remained in close contact with the Department of Agriculture, which he kept supplied with nucleus stocks of leading cereals and grasses These in turn became available to the various county committees of agriculture, by which they were tested and reported on in due course Prof Caffrey was also in close contact with plant breeding stations abroad, and he introduced many foreign cultivars of wheat, oats and barley They were tested against cultivars commonly grown in Ireland and numerous crosses made with the most promising sorts During four decades he produced not only varieties of wheat suitable to local soil and climatic conditions, but also improved varieties of oats and grasses In crossing and breeding, Prof Caffrey was particularly interested in the reaction of the hybrids to disease resistance, and one outstanding case of his work on this aspect may be quoted here At Glasnevin, year after year, the most common and serious disease of wheat has been yellow rust (*Puccinia glumarum*) To combat this, Caffrey produced the cultivar Glasnevin Rosa, a wheat which was immune to yellow rust for seven years, a period which is about usual for varieties bred immune or resistant to rust diseases before they become attacked by new strains of the pathogen which develop in the meantime

Close co-operation always existed between the Plant Breeding Division and the Plant Pathological Division at Glasnevin , and down the years the latter Division has been indebted to Prof Caffrey on many occasions for directing attention to outbreaks of disease and to the appearance of new pathogens on cereal crops

Although Prof Caffrey's entire professional career was devoted to plant breeding, he had a wide interest in all agricultural subjects He was a founder Council member of the Irish Grassland Association, a member of the Agricultural Commission appointed by the Government to examine agricultural development in the late 'thirties, and in general he identified himself with many agricultural developments. He was equally at home with students and scientific audiences, and as a lecturer on behalf of the Royal Dublin Society he became intimately acquainted with and highly appreciated by a wide range of farmers all over the country.

Prof. Caffrey's outspoken manner, genial personality and hearty laugh will long be remembered by all who knew him. He was predeceased by his wife some years ago, and he is survived by three sons and three daughters, for whom the greatest sympathy is felt. R. McKay

Dr. E. J. Holmyard

Eric John Holmyard was born on July 11, 1891, at Midsomer Norton, Somerset, and all his life he was a faithful man of Somerset. He was a scholar of Sidney Sussex College, Cambridge, and after graduation he served as a sixth-form science master at Marlborough College during 1917–19. He then became head of the Science Department at Clifton College, an appointment which he filled with signal success for the twenty years 1920–40. It was at Clifton that his best work was done. In 1941 he became editor of *Endeavour*, retiring in 1954 to live at Clevedon, Somerset. Among his other activities, he was chairman of the Society for the Study of Alchemy and Early Chemistry and co-editor of a "History of Technology" in five volumes.

Holmyard, as a teacher, well knew the capacities of young pupils at school, and his books on inorganic and organic chemistry of this standard have deservedly been very popular. They are written in a lucid and attractive style and many readers of this notice must owe their introduction to chemistry to them. In collaboration with F. A. Philbrick, he wrote a more advanced book on theoretical and inorganic chemistry which has also been very successful. All these books present the basic facts of chemistry as an experimental science, relating them to general principles in a way which gives them significance and interest, but the theory is kept in proper proportion, so that those who gained their knowledge from them in the past will now have very little to unlearn.

Dr. Holmyard, who was a member of the Royal Asiatic Society, will probably be best remembered for his profound studies of Muslim chemistry. He was well equipped with a knowledge of Arabic, and in this field he was a recognized authority. He made a special study of Jābir ibn Ḥayyān and the writings attributed to him. He published some Arabic texts, brought to light some little-known works of Jābir, and re-interpreted some which had previously been studied. More recent research has shown that the problem of Jābir is very difficult and much remains to be cleared up, but Holmyard's pioneering work has a permanent value. He showed that the theory which dominated alchemy and early chemistry, that metals are composed of mercury and sulphur, was taught by Jābir, who derived it from a statement in the "Meteorology" of Aristotle.

In collaboration with his pupil at Clifton, Mandeville, Holmyard published the Arabic text and a translation of a work known in Latin as by Avicenna and showed that it is, in fact, part of the genuine *Shifā'* of Ibn Sīnā. This text, which denies the transmutability of species and stigmatizes alchemical gold as fraudulent, was a puzzle in the Middle Ages, when it was thought to be part of the "Meteorology" of Aristotle. Holmyard also edited and translated an alchemical text of Abu'l Qāsim al 'Irāqī. In all these studies he made much use of the writings of Jildakī, available only in manuscripts, and established their value as a source of information on Muslim alchemy. The work in this field by Holmyard completely changed the outlook on Muslim chemistry which prevailed when he began.

Holmyard wrote some excellent small books on the history of chemistry, the best known being his "Makers of Chemistry" and his recently published "Alchemy". These are accurate and authoritative, and it is to be regretted that he did not write a general survey of Muslim chemistry which he was so well qualified to undertake.

Holmyard was modest and unassuming, ready to put his knowledge at the disposal of those who asked it, with a cool and critical outlook in scholarship, expressing himself concisely and avoiding polemics. His learning sat lightly upon him, and for all he cared it could remain unknown in circles incapable of understanding it. He was open and friendly and in whatever company he found himself his quiet charm and delicate sense of humour, wholly free from malice, endeared him. He was a member of Clevedon Golf Club. He died at Clevedon on October 13, and among those who valued his knowledge and friendship his death leaves a vacant place which it will be hard to fill. J. R. Partington

NEWS and VIEWS

Royal Society: Award of Royal Medals

H.M. the Queen has been graciously pleased to approve recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year as follows: to Prof. R. E. Peierls, professor of mathematical physics in the University of Birmingham, for his distinguished work on the theoretical foundations of high energy and nuclear physics; to Prof. P. B. Medawar, Jodrell professor of zoology and comparative anatomy at University College, University of London, for his distinguished contributions in the field of tissue transplantation immunity and acquired tolerance.

Geological Society of London: Foreign Members

The Geological Society of London has elected to foreign membership the following distinguished geologists: Academician V. V. Belousov, of the Academy of Sciences, Moscow, in recognition of his studies on sedimentation and geotectonics; Prof. J. A. Broggi, of Lima, Peru, for his work in the advancement of geological science in Peru and his contributions to Peruvian geology; Academician D. V. Nalivkin, of the Academy of Sciences, Moscow, in recognition of his contributions to the geology of the Soviet Union and especially of his part in the preparation of the recently published geological map of that country , Academician N S Schatsky, of the Academy of Sciences, Moscow, for his work on tectonics, stratigraphy and economic geology , Dr F Prantl, vice-president of the National Museum, Prague, in recognition of his distinguished researches in palæography, stratigraphy and palæontology , Prof Norman D Newell, of the American Museum of Natural History, New York, for his contributions to invertebrate palæontology and his work on reef deposition

British Broadcasting Corporation Science Unit

A Science Unit has been established by the British Broadcasting Corporation with the object of providing a more extensive coverage of science in sound programmes The senior member of the Unit is Dr Archie Clow, who joined the B B C in 1945 and has produced many science series and individual talks, notably the two weekly series "Science Survey" and "Who Knows ?", in which leading experts deal with all kinds of scientific developments in a non-technical way The Unit is also responsible for "Science Review" and Third Programme science talks and discussions Recently, Mr David Edge joined Dr Clow in the Talks Department Both received their earlier education at Aberdeen, the former at Aberdeen Grammar School and the latter at Robert Gordon's College Mr Edge did research work in radio astronomy for three years after taking his degree in physics at Cambridge in 1955

A third member of the Corporation staff who is contributing to the expansion of science broadcasts is Mr C L Boltz, who is now attached to the News Division as science correspondent (*Nature*, 183, 1231 , 1959) He formerly worked for seven years in a similar capacity in the B B C 's European Service Succeeding Mr Boltz in the European Service is Mr Bryan Silcock, who was born in Liverpool in 1933 and has since 1957 been an assistant editor of *Nature* He went to Dartington Hall School in Devon, and after National Service in the West Yorkshire Regiment and the Royal Artillery, to Jesus College, Cambridge, graduating with honours in natural science

British Commonwealth Education Liaison Committee

In a written answer in the House of Commons on November 12, the Minister of State for Commonwealth Relations, Mr C J M Alport, stated that in accordance with the recommendations of the Commonwealth Education Conference, representatives of all member countries in the Commonwealth met in London on October 27 under the chairmanship of Sir Henry Lintott It was proposed to establish a Commonwealth Education Liaison Committee, comprising one representative of each member country and of Nigeria, and in addition the United Kingdom would appoint a member to represent the other Colonial territories This Committee would follow up and record progress on the schemes of assistance agreed at the Oxford Conference and would also consider suggestions for the further improvement of Commonwealth co-operation in education, and, in particular, it would prepare material for submission to the next Commonwealth Education Conference, to be held in India in the winter of 1961–62, at the invitation of the Government of India The chairman would be Sir Philip Morris, and under the general direction of the Liaison Committee there would be a Commonwealth Education Liaison Unit, consisting initially of a director (who would also be secretary to the Committee) and one administrative assistant The Unit would supplement normal direct dealings between the countries of the Commonwealth on education, and would deal on request with inquiries from education authorities in Commonwealth countries and generally act as a reference centre The cost of the Unit would be shared between member countries of the Commonwealth

United States and Great Britain to exchange Data on Advanced Gas-cooled Reactors

The United States Atomic Energy Commission and the United Kingdom Atomic Energy Authority have signed a five-year agreement to exchange technical information on advanced gas-cooled reactors The exchange, effective as from November 16, will be carried out under the terms of the agreement between the two countries for co-operation in the civil uses of atomic energy, which has been in effect since 1955 Data will be exchanged on development, design, construction and operation, as well as on related research and development, of the advanced gas-cooled reactors being built at Windscale, England, and on the U S experimental reactor project of this type at the Oak Ridge (Tennessee) National Laboratory Information exchanged under this agreement will be made available to British and American industry

British Book Exhibition in Moscow

A large exhibition of British books and periodicals sponsored by the British Council and the Soviet Ministry of Culture is opening in Moscow on November 21 for a fortnight A similar exhibition of Russian books and periodicals will be shown at the Festival Hall in London next February This will be the largest exhibition of British books and periodicals to have been shown in the U S S R at any time, so far as is known Between three and four thousand books will be exhibited together with six hundred periodicals a display of posters and large photographs The exhibition will be shown in the main lecture hall of the Lenin Library, one of the largest libraries in the world The books selected by the British Council have been provided free of charge by British publishers through the co-operation of the Publishers' Association The main emphasis lies on science and technology, although there are important sections dealing with the arts and the humanities Under the terms of the agreement made with the Soviet Ministry of Culture, there are no sections on religion, politics or economics Two-thirds of the periodicals are on medical and scientific subjects At the end of the exhibition all the British material will be handed over to the Soviet Ministry of Culture for use in Russian libraries and cultural institutions

New Zealand Research on Weed Transportation

Weed species are sometimes inadvertently introduced into one country from another, but it is not always possible to establish the means by which this occurs A J Healy, of the Botany Division, Department of Scientific and Industrial Research, Christchurch, has given some particular instances of introduction of foreign species into New Zealand (*New Zealand Journal of Agricultural Research*, 2, No 2 , April 1959) The first example is a straw envelope from a whisky bottle picked up in a rubbish heap on a North Canterbury farm The envelope contained a flowering stem of bindweed, *Calystegia sepium*, portions of an inflorescence of tall oat grass, *Arrhenatherum elatius*, and a bent grass, *Agrostis* sp Such containers when discarded are generally thrown on rubbish heaps and other sites suitable for weed establishment A plate-glass container from an English source, examined in the Wellington district, contained wheaten straw in which was found portions of Californian thistle, *Cirsium arvense*, cleavers, *Galium aparine*, willow weed, *Polygonum*, fruiting material of *Beta* sp , nipplewort, *Lapsana communis*, and a hemp nettle, *Galeopsis* sp This straw was being used locally both for compost heaps and in racing pigeon cages, which would further serve to disperse the weeds throughout the country An examination of the trouser cuffs of a tourist returned from a trip through Spain, France, Switzerland and Italy revealed fruits of Gramineae and Compositae

University News

Birmingham

The title of reader in mathematical physics has been conferred on Dr J G Valatin, senior lecturer in mathematical physics The following appointments have been made to lectureships Dr H B Griffiths (pure mathematics). Dr J K Brown (chemistry), Dr M E Davies (botany), Dr Nancy Montgomery (botany), Brenda Manly (zoology), J Cohen (zoology), C R Sladden (biology in the department of zoology), Dr D J Blundell (geology), I R Smith (electrical engineering), K B Haley (engineering production), Dr V G Jenson (chemical engineering), K A Redish (computing in the Department of Mathematical Physics), N A Dyson (physics), N A J Rogers (chemistry)

The annual lecture of the Institute of Education is to be named "The Raymond Priestley Lecture" in recognition of the help which Sir Raymond Priestley gave to the Institute of Education when the Institute was established

Preliminary plans have been approved for a building for highway and traffic engineering as an addition to the new Civil Engineering Building

Oxford

The following research grants are announced from European Research Associates, Brussels, £1,200 for one year from September 1, for research on acetylene chemistry being carried out in the Dyson Perrins Laboratory under the direction of Prof E R H Jones, from the Department of Scientific and Industrial Research a grant not exceeding £3,400 for the year ending July 31, 1960, for the maintenance of the 140 MeV synchrotron for nuclear physics research in the Clarendon Laboratory, from the Colonial Medical Research Council a grant not exceeding £2,500 for a further two years ending August 31, 1961, for the study of the sensory neurohistological changes in skin infected with leprosy, being carried out in the Department of Human Anatomy under the direction of A G M Weddell, reader in human anatomy, from the Smith, Kline and French Research Institute a grant not exceeding £1,500 for research on the electrophysiology and pharmacology of smooth muscle to be carried out in the Department of Pharmacology by E Bulbring, from the United States Public Health Service a grant not exceeding 30,600 dollars for the year beginning September 1, 1959, for research in the Department of Biochemistry under the direction of Sir Hans Krebs

Announcements

Prof C F Carter, Stanley Jevons professor of political economy and Cobden lecturer in the University of Manchester, has been appointed a member of the Council for Scientific and Industrial Research, in succession to Prof E A G Robinson, who retires on completion of his period of service Prof Carter's interests are in the field of applied economics He is the author of "Industry and Technical Progress" (with Prof R B Williams), published in 1957, and "Investment in Innovation", 1958, he is chairman of the Science and Industry Committee of the Royal Society of Arts, the British Association for the Advancement of Science and the Nuffield Foundation

The Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers, in association with Interscience Publishers, Inc , has announced the publication of a new series of books entitled "Metallurgical Society Conferences", each volume being the proceedings of a technical conference sponsored by the Society through one of its technical committees It is hoped by these means to provide for co-ordinated and comparatively rapid publication of scientific and engineering papers of interest to metallurgists The first volume in the series, "Flat Rolled Products, Rolling and Treatment", can be ordered from Interscience Publishers, Inc , 250 Fifth Avenue, New York 1, New York (price 3 75 dollars)

The Population Council Incorporated of New York is making grants totalling 89,348 dollars over three years to the National Institute for Research in Dairying The award is in support of researches on cervical mucus, with particular reference to the control of fertility, to be carried out in the Physiology Department under the direction of Dr S J Folley

Industrial and Trade Fairs, Ltd , announce that a conference on New Engineering Materials and Design will be held in conjunction with the first Engineering Materials and Design Exhibition at Earls Court, London, during February 22–26, 1960 Among the subjects selected for discussion at the conference will be safety factors and the appearance in design Further information can be obtained from the Secretary for the Conference on Engineering Materials and Design, Drury House, Russell Street Drury Lane, London, W C 2

At the annual general meeting of the Photobiology Group, held at the National Physical Laboratory, Teddington, on November 6, Dr D Vince, of the Department of Horticulture, University of Reading, was elected honorary secretary in succession to Dr E M F Roe

The sixth National Symposium on Reliability and Quality Control in Electronics will be held at the Statler Hilton Hotel, Washington, D C, during January 11–13, 1960 Further information can be obtained from Mr R Brewer, The Research Laboratories, The General Electric Co , Ltd , Wembley, Middlesex

Errata In the communication entitled "Effect of Sorbitol on the Urinary Excretion of some B Vitamins in Man" in *Nature* of September 19, p 911, the numerical values of the ordinates have been inverted , thus, reading from below upwards, the values for riboflavin should be 150, 200, 250 μgm , those for thiamine, 10, 20, 30 μgm , those for N-methylnicotinide, 2, 3 mgm

ASSISTANCE FOR UNDER-DEVELOPED COUNTRIES

THE Queen's speech at the opening of Parliament on October 27 referred to the Government's urgent concern to improve conditions of life in the less-developed countries of the world and its intention to promote economic co-operation and support plans for financial and technical assistance. This was warmly welcomed in both Houses in the subsequent debates. Lord Stoneham asked for further information on this matter and, emphasizing its urgency, stressed the need to seek international agreement to stabilize basic commodity prices, the fall in which in 1958 had cost the under-developed countries 2,000 million dollars. Only urgent and increasing financial and technical assistance can avert the human suffering implicit in the two-thirds increase forecast in the population of Asia in the next fifteen years. The Marquess of Lansdowne was unable to specify the exact increases but assured Lord Stoneham that the Government intended to increase considerably contributions in the various fields of aid to under-developed countries. Lord Home also expressed the view that the foundation of peace probably lies in bringing the standard of living of the under-developed nations nearer to that of the industrial nations. In replying on the debate, the Lord Chancellor said that under the Colonial Development and Welfare Acts, £140 million would be available for the Colonial territories during the next five years, with up to £100 million more by way of Exchequer loans. External private investment of all kinds averaged £90 million a year, two-thirds being from the United Kingdom, and it was estimated that the United Kingdom's financial contribution to the Colonial territories averaged £100 million a year in 1956–58. Economic and technical assistance to all overseas countries and territories from United Kingdom public funds rose by a third in the past financial year to about £100 million, and is expected to increase similarly this year, exclusive of military assistance and certain emergency and miscellaneous expenditure amounting to about £30 million. Subject to agreement on the constitution for the new International Development Association, Parliament would be asked to put £50 million into the new Association.

In the House of Commons, Mr. J. Harvey, referring to the growing awareness of the need to give greater assistance to the under-developed territories, suggested that the Government might take some initiative in stimulating such interest so as to enlist voluntary contributions in addition to Government funds for this purpose. Mr. W. Owen suggested the Co-operative movement as a possible source of experience, knowledge and enterprise in this connexion, and Sir John Barlow advocated use of the International Monetary Fund to stabilize world production and prices of such primary commodities as tin and rubber. Mr. H. A. Price, pointing out that we are already devoting more than 1 per cent of our national expenditure to the under-developed countries, thought that we could do much more and that these territories offer great potentialities for the production of increased wealth. The President of the Board of Trade, Mr. R. Maudling, referred to our need to increase our balance of payments position if we are to play our full part in helping the development of these countries, and Mr. J. Arbuthnot suggested that reduced taxation in these countries would greatly assist in the creation of the conditions for development.

Mr. Anthony Head emphasized the vital importance of giving adequate attention to the backward, dependent and under-developed countries during the next five or ten years. He directed attention more particularly to the educational problem, and urged that here the West needs to overhaul its whole approach, and that co-ordinated effort is imperative. In this he was supported by Mr. K. Zilliacus, who pointed out that economic co-operation and the provision of financial, economic and technical assistance to backward countries internationally through the United Nations represent the support of constructive and modernizing forces. Sir Henry d'Avigdor-Goldsmid and Mr. J. Grimond spoke strongly in the same sense, Mr. Grimond referring also to the importance both of the type of government which is established in the newly independent territories and of education, including technical education. Mr. Philip Noel-Baker was somewhat critical of the magnitude of our present contribution. Although our contribution to United Nations Technical Assistance has risen from 2·5 to 3·0 million dollars, the Commonwealth has every year received far more from Technical Assistance than it has paid in, and against the increase in our contribution to the United Nations Special Fund from 1 to 5 million dollars should be set the schemes, costing 15 million dollars, for work in the Commonwealth already submitted by the Colonial Office to Mr. P. Hoffman. Moreover, the £1,000 million loan to the under-developed countries by the International Bank during the first twelve years of its existence was less than one-tenth of the extra capital required during the following ten years to achieve Mr. Hoffman's objectives.

Replying on the debate, the Minister of State for Foreign Affairs, Mr. J. Profumo, recognized the importance of the struggle for men's minds and the part which the Chancellor of the Duchy of Lancaster has to play in that connexion. He also took up the point about education, which had been stressed separately in the Queen's speech in a reference to the introduction of legislation to implement recommendations of the Commonwealth Education Conference, which had been warmly welcomed by Mr. E. Gardner and, in the House of Lords, by Lord Hastings. Lord Home, noting that the presence of 42,000 overseas students in Great Britain put a considerable strain on our universities and technical colleges, welcomed Lord Hastings's reference to the importance of education; nevertheless he thought that the task of equipping youth to meet the intellectual, physical and moral challenge of the time will strain our resources to the full. Apart from a reference by Mr. P. Wall on November 2 to the way in which the under-developed countries in Asia, Africa and the Middle East are beginning to realize the importance of European capital and European technicians, there was no further reference to the under-developed countries in the debate on the Address, although others besides Mr. Wall stressed the importance of education when the position in Central Africa was discussed at some length on November 2.

NEW RESEARCH LABORATORIES FOR THE CAMBRIDGE INSTRUMENT COMPANY, LTD.

By DR. M. C. MARSH
Head of Research Department

ON October 14 a new block of research laboratories for the Cambridge Instrument Company, Ltd., was opened by Lord Adrian, Master of Trinity College and until recently Vice-Chancellor of the University of Cambridge. Following the opening, about 120 distinguished guests were entertained to lunch by the Directors of the Company, and they afterwards had an opportunity to inspect the new accommodation. On October 16 an open day was arranged for shareholders and for guests from the University and from several research establishments in the neighbourhood of Cambridge. About four hundred guests availed themselves of this opportunity. On both occasions the guests were received by Dr. P. Dunsheath, chairman of the Board of Directors, and Mr. H. C. Pritchard, managing director of the Company.

This new building is the result of a decision to expand greatly the research and development facilities of the Company. It provides about three times the previous floor area and permits the whole of these activities, which before this were dispersed in various parts of the works, to be brought under one roof, together with a design and drawing office.

The new laboratories are situated in Chesterton Road, adjacent to the Cambridge factory. They have a very fine view over the River Cam and over Jesus Green and provide accommodation suited to the work to be undertaken. As will be seen from Fig. 1, the clean, modern appearance of the building is emphasized by large windows that run the length of the first three floors and also by the colour contrast afforded by the light buff brickwork of the side walls and the dark green of the slate panels beneath the front windows. The building, which has a floor area of approximately 20,000 sq. ft., has four storeys and is provided with a three-storied entrance block and a rear link block giving access to the factory buildings. The mode of construction gives a clear area on each floor entirely uninterrupted by columns or beams, and extensive use has been made of modern building materials and fittings, such as red thermoplastic flooring, heating coils embedded in the structure, double-glazed windows and acoustic panels.

The entrance block is distinguished by a spacious entrance hall, which is decorated in contemporary style and contains an instrument showroom and a reception area. The block also houses offices and a lift serving all floors.

The laboratory block consists of four floors approximately 100 ft. long and 40 ft. wide. On the ground floor is the mechanical engineering laboratory with its offices, stores and constant-temperature room. Instrument makers' benches and experimental benches are arranged mainly beneath the front windows, and the remaining floor space is taken up by precision machine tools and mechanical laboratory equipment. The first floor is devoted to physics and electronics. It has a large and airy main laboratory, offices, dark room and optical laboratory, standards room and electronics workshop. The second floor houses the physical chemical laboratory which, in addition to offices, has special rooms for balances, glass-blowing and for chemical preparations. Polythene and 'Vulcathene' fittings are used in a special system for draining chemical waste from this floor. The top floor is taken up by design and drawing offices. Excellent lighting is provided by a number of roof-lights in addition to windows running the entire length of both walls. Along the front of this floor is a covered balcony, edged with flower-boxes.

In designing the laboratories, great stress has been laid on versatility. With this in view all the services are laid in trunks of ample size, and it would be an easy matter to add any facilities not originally provided. Besides the usual supplies of gas, water and electricity, there is a special low-voltage electrical supply for portable apparatus. At 18 places there are boards containing four terminals and an appropriate switch. From a central control board it is possible to feed to these terminals a three-phase and neutral supply of any required voltage, single-phase a.c. of any voltage up to 250 volts at frequencies between 25 and 60 c./s., a.c. stabilized against changes of voltage and frequency and d.c. between 0 and 250 volts. These supplies are obtained from trans-

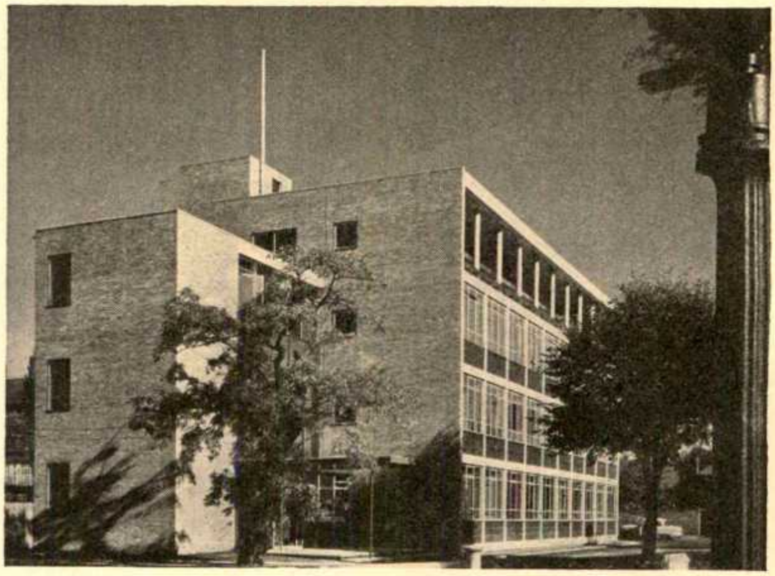

Fig. 1. Research Laboratories of the Cambridge Instrument Company, Ltd.

formers, stabilizer and a Ward Leonard set with a connected motor alternator The last two are situated in a cellar but are controlled from two points in the laboratories On the third floor a large glass de-aerator of special design has been fitted in order to supply oxygen-free water for researches on boiler feed-water problems Compressed air of high and low pressure is supplied to all laboratories, with an extra high-pressure supply in the mechanical laboratory

The building was completed in the remarkably short time of just under one year by Messrs J Jarvis and Sons, Ltd (London and Manchester), to the design of the architects, Messrs Edward D Mills and Partners Light oak furniture with teak tops has been supplied to all the laboratories by Messrs Baird and Tatlock (London), Ltd

These laboratories are now fully occupied and, with an expanding staff, a large programme of research and development work is being undertaken This programme relates to improvements to instruments which are already being manufactured, as well as to a number of entirely new projects in which the Company is interested.

CARBON-DATING CONFERENCE AT GRONINGEN

SEPTEMBER 14–19, 1959

ON the invitation of Prof Hl de Vries (Natuurkundig Laboratorium) and Prof H T Waterbolk (Archaologische-Biologisches Instituut), of the University of Groningen, a small conference of scientists from carbon-dating laboratories was held in Groningen during the week September 14–19 It was similar in character to the conferences held in Copenhagen, Cambridge and Andover, Mass , already reported in *Nature*[1,2] and *Science*[3] Twenty-two dating laboratories were represented, some well established and others just getting into their stride, from twelve countries We were happy for the first time to welcome Russian colleagues at these meetings Some thirty-five communications were made to the meeting, which was partly concerned with the technique of carbon-dating and partly with selected aspects of its application to geological and archæological problems

There was less emphasis than hitherto upon the techniques of counter and circuit design, but nonetheless there was a very interesting survey of the methods in use at various laboratories Two laboratories described their scintillation counting techniques, that at Saclay, using paraldehyde, and that at Trinity College, Dublin, using methanol While a few laboratories use acetylene or methane in their proportional gas-counters, it seems that the majority of dating laboratories now favour carbon dioxide counting Considerable emphasis was laid on the need for careful pre-treatment of samples, especially with difficult materials such as bone, charcoal, cave-earths and all samples of great age Accounts were given of several promising investigations into matters affecting the principles of the method and its applications, as, for example, those at Heidelberg illustrating possible seasonal variations of radiocarbon content of the atmosphere Particular interest was attracted by an account of the joint investigations of Cambridge, Copenhagen and Heidelberg upon possible fluctuations in the initial atmospheric carbon-14 concentration during the past 1,200 years , this is a promising extension of ideas recently suggested by de Vries[4] as possibly offering insight into past climatic changes

Without attempting to summarize all the interesting contributions, it may suffice to point to two or three fields in which the application of carbon-dating has now apparently led to a highly significant advance in knowledge First, we may note a series of datings made at Groningen of the earliest Neolithic cultures from south-eastern and central Europe, indicating a spread from the Near East across these regions as early as 4000 B C , these findings were paralleled to some extent by numerous datings made in Pisa upon Italian material

Several contributions concerned the dating of stages of the last glaciation characterized by stratigraphy, archæology or biological and climatic evidence Here the contribution of Groningen was particularly important, since the technique of isotopic enrichment had permitted the addition of several half-lives to the maximum possible age attainable[5] With favourable materials that warrant this costly and lengthy process, ages as great as 64,000 ± 1,100 years are attainable This in fact appears to be the date of the first mild interstadial period after the last (Eemian) interglacial There is considerable evidence now for an interstadial about 30,000 years ago at several places in western Europe From the American laboratories comes very convincing evidence obtained by dating ocean cores, and deposits both in the Caribbean and in salt lakes, for a very abrupt amelioration of climate about 11,000 years ago It is striking that this climatic break corresponds exactly with the well-dated Late-Glacial period of climatic change in Europe

A substantial part of the time of the meeting was properly devoted to various matters of co-ordination of the work of different laboratories The successful outcome was reported of two policy decisions taken at earlier conferences, namely, to establish an agreed system of publication of date-lists and to publish a punch-card system of all published dates The first of these objectives has been met by the publication of the Radiocarbon Supplement of the *American Journal of Science*, the first volume of which appeared in May of this year The second was met by the formation of Radiocarbon Dates Association, Inc Mr Fred Johnson gave a description of the principles he had adopted in designing the punch-card system and reported the first issue of cards to subscribers It is not yet sufficiently widely known by archæological, geological and biological laboratories concerned with the history of the past 70,000 years how massive is the contribution already made by carbon-dating to knowledge of this period, nor what a very rich source of information this punch-card system will provide. (Inquiries for subscriptions to the carbon-dating punch-card index should be directed to Radiocarbon Dates Association, Inc , Robert S Peabody Foundation for Archæology, Philips Academy, Andover, Massachusetts, U S.A)

With regard to future procedure, it was decided that all carbon-dating laboratories should check by a common standard and that this should be the oxalic acid standard of the U S Bureau of Standards It was agreed that a value of 95 per cent of this standard activity could be taken as the agreed radiocarbon activity for organic material (but not shells) originating in A D 1950 This decision should remove many of the minor difficulties caused by the different laboratories having individual standards of contemporary activity on which to base their calculations of age, and it is hoped that either the next or the next but one date-list of every laboratory will be based upon this agreed standard, which will take care of the industrial carbon and hydrogen-bomb effects upon recent samples. It was at the same time recognized that the carbonate sample provided by Heidelberg would be a further check of importance , that laboratory has undertaken the co-ordination of all inter-laboratory calibration measurements

It was agreed to defer decision on a carbon-13 standard, pending exact absolute determinations to be made in the Lamont Laboratories

It was agreed to use the methods of presentation of bibliography now employed in the Radiocarbon Supplement and in *Quaternaria* the conference also recommended that new dating stations should adopt as their index letters the most distinct and simple combination possible, avoiding those that have already been used even by stations not at present producing dates

While there was no agreement as to whether dates ought preferably to be expressed as B P (before the present), or B C (and A D), there was considerable sympathy for the view that dates primarily relevant to archæology should be given in the B C /A D scale, even where the date B P had also been given

Members of the conference had the concentration of lecture room attendance broken by visits to Prof de Vries's laboratory, to the great peat bog and moraine region south of Groningen and to the dramatic areas of reclamation where carbon-dating is assisting the Geological Survey to provide fundamental knowledge of the stratigraphy of coastal deposits

The thanks of all participants are due to all our Dutch hosts, to the Rektor Magnificus of the University of Groningen, to the Royal Dutch Shell Company, to the Chief Engineer and Director of the Rijks Waterstaat, and above all to the primary organizers of the conference H GODWIN

[1] Godwin, H , *Nature*, 174, 868 (1954)
[2] Levi, H , *Nature*, 176, 727 (1955)
[3] Johnson, F , Arnold, J R., and Flint, R F , *Science*, 125, 240 (1957)
[4] Vries, Hl de, *Proc Kon Ned Akad van Wetenschappen*, *B*, 61 (2), 1 (1958)
[5] Vries, Hl de, Vries, A E de, and Harris, A , *Science*, 128, 472 (1958).

ENZYMES IN THE FOOD INDUSTRY

THE Committee of the Food Group of the Society of Chemical Industry has an established reputation for organizing symposia on subjects of vital importance and with a wide range of interest to food scientists and technologists The most recent, held on October 1–2, dealing with enzymes associated with the manufacture, storage and distribution of food, attracted an audience which taxed the capacity of the hall of the Royal Society of Medicine in which it was held The organizers very wisely decided to limit the scope of the contributions and to divide them roughly into two groups one dealing with the production of enzymes and their use in manufactured foods and the other with the activity, both useful and deleterious, of naturally occurring enzymes in foods.

Dr Malcolm Dixon opened the symposium with a paper, giving in his own characteristic way the necessary background information on the types of reactions which may be catalysed by enzymes, and such of their properties as would have a bearing on the matters discussed by later speakers The value of such an introduction to a symposium covering a broad field of biochemistry cannot be too highly stressed when it is appreciated that the audience was composed mainly of persons connected with the food manufacturing and processing industries, specialists maybe in rather limited fields, who frequently find it hard to keep abreast of fundamental developments

The remainder of the first day was given over to papers dealing with fungal amylase, invertase, rennin, glucose-oxidase, the pectin-degrading enzymes and proteinases from plants and micro-organisms The main interest in fungal amylase and invertase was in the methods adopted to secure conditions of culture of the selected organism so that high yields of high-purity enzyme are possible on a commercial scale The discussion on the papers not unexpectedly centred around the newer applications of enzymes by the food industry and in particular the use of amylase in bread-making, the application of such proteinases as papain, bromelin (from pineapple) and ficin (from figs) to meat with the view of increasing its tenderness, and the recent availability of glucose oxidase as an oxygen scavenger in packaged foods

The proceedings of the first day having presented the enzymes in a favourable light, as processing aids in a variety of food products, the second day, devoted to "Innate Enzymes Their Action and Control", revealed the reverse side of the medal and showed enzymes in a less co-operative mood This was not unexpected . Dr Dixon, in his introductory remarks, had already pointed out that foods are the product of enzyme action in the living plant or animal and are metabolized after consumption by enzyme action in the body of the consumer, stressing the fact that in the living cell the urge of the enzyme processes is towards synthesis and that enzyme changes in foods, which can be regarded as post-mortem changes, may well be deteriorative in character It is, however, sometimes difficult to draw the line , the enzymic ripening of fruit leads progressively into the deteriorative changes of over-ripening Other cases are more specific papers presented during the day dealt with enzymic deterioration in colour (blackening of potatoes by polyphenolase), in flavour ('soapiness' in coconut and palm kernel oil products due to liberation of free fatty acids by lipase action) and in nutritive value (oxidation of ascorbic acid and of vitamin A precursors in plant tissues)

The problem of control is a formidable one 'Cold storage merely delays but does not prevent enzymic deterioration, since enzyme reactions, like all other chemical reactions, are slowed but not stopped by lowering of temperature Other standard methods, such as the addition of inhibitors or competitive substrates, are by no means universally applicable Probably the most commonly used procedure is that of heat inactivation ('blanching'), but this can lead to unwanted structural changes in fruits and vegetables At present there is no simple and universal solution

It must be said that on one point the arrangement of the symposium was open to critical attack, namely, the lack of time available for free discussion It is in this discussion that the value of a symposium such as this largely resides, both for the audience and for the contributors themselves Arrangements had been made for the discussions to be opened by appropriate authorities and these authorities presented what virtually amounted to additional contributions, comparable in weight and importance to those of the main contributors On this account, the unscripted discussion was seriously restricted, particularly at the final session, and a number of potential questions had to remain unasked and unanswered This was undoubtedly a loss and one can but ask that the point should be borne in mind when future symposia are being planned

It is, however, pleasant to record that the symposium went with a swing to the end and was closed by the clock there was no noticeable whittling away of the audience as special interests were disposed of In its lighter moments the meeting considered future possibilities , these included 'tailored' enzymes for specified purposes and the application of enzymes to the restoration of flavour in over-cooked cabbage It was also pointed out that one speaker had coined a new word—the verb "to enzyme" The purists may refuse to accept this innovation, but we must all accept the importance of the process it describes

BIOCHEMICAL RESEARCH IN INDIA

GOLDEN JUBILEE SYMPOSIUM

A SERIES of symposia was organized by the Department of Biochemistry, Fermentation and Pharmacology Laboratories of the Indian Institute of Science, as part of the celebrations of the golden jubilee of the Institute, during August 28–30, and was attended by more than two hundred scientists including fifty delegates representing important centres of biochemical research in the country The subjects covered were "Biology and Biochemistry of Micro-organisms", "Enzymes" and "Vitamins"

The symposia were inaugurated by Dr S Bhagavantam, the director of the Indian Institute of Science, and the first day of the session was presided over by Major-General S L Bhatia, who spoke on the "Progress of Physiology and Biochemistry in India" Prof P S Sarma, who presided over the proceedings of the second day, outlined the contributions in enzyme chemistry made by the late Prof K. V Giri (see *Nature*, 182, 1201 , 1958) Dr V N Patwardhan, who took the chair on the third and final day of the symposium, gave an address on the mode of action of vitamin D on which he and his group have been working for the past two decades He and his collaborators have adduced experimental evidence to show that vitamin D acts presumably by promoting the synthesis of citric acid in the epiphyseal cartilage Dr. V Subrahmanyan, director of the Central Food Technological Research Institute, Mysore, who was professor of biochemistry in the Indian Institute of Science from 1931 until 1949, reviewed the work done in the department during his regime He gave a brief account of the development of the Bangalore process of composting, the elucidation of the principles of sewage purification, the preparation of a material from paddy husk for defluorinating fluoride-containing waters and the preparation of insulin and other hormones from slaughter-house material and vegetable 'milk' from soya bean Prof M Sreenivasaya, who was one of the pioneers in enzyme chemistry during the early years of the Biochemistry Department, described the elegant method developed by him for the study of enzymes both by the ultra-micro- as well as by micro-dilatometric methods

Sixty-nine original research papers were presented at the symposia, and only a selection can be mentioned here

M G Bhat, of the Indian Institute of Science, read a paper on the nutrition and metabolism of *Pseudomonas convexa* var *hippuricum* representing the work done by her in collaboration with Drs T Ramakrishnan and J V Bhat Detailed investigations with regard to the nutritional requirements and metabolic pathways of this organism, which was isolated from soil using the enrichment culture technique, were outlined and a new pathway of benzoate breakdown by the bacteria involving salicylate, a mechanism different from the classical scheme of the metabolism of the aromatic ring, described M K Subramanyam (Indian Institute of Science) gave a résumé of his studies on the cytology of yeast, which included the demonstration of the presence of a nucleus and a vacuole as well as the occurrence of nuclear and vacuolar membranes in the yeast cell He also pointed out the general similarity of the structures of yeast and plant nuclei

M Chakravorty and D P Burma, of the Bose Institute, Calcutta, presented a paper on "Microbial Synthesis of Protein in Relation to the Biogenesis of Nucleic Acids" Using phosphorus-32 and sulphur-35, they have shown that, in the resting cell of *Azotobacter vinelandii*, conditions under which nucleic acid synthesis is inhibited lead to a decrease in protein synthesis On the contrary, it was found that the incorporation of phosphorus-32 into the nucleic acid continued in an uninterrupted manner even when protein synthesis was inhibited P S Sarma and co-workers, of the University Biochemical Laboratory, Madras, working on metal requirements of nicotinamide deaminases, have investigated the inhibition by metal-chelating agents of nicotinamide-deamidating systems in cell-free extracts of micro-organisms and the soluble fractions of pigeon liver. A study of the reversal of the inhibition, produced by α-α′-dipyridyl with various metal ions, has shown that the enzyme systems in the insect *Corcyra cephalonica* St , pigeon liver and chick kidneys are reactivated by Fe^{++}, that in *A niger* by Mg^{++} and the one in *N crassa* by Mn^{++}.

The detection and purification of a stereo-specific dihydrolipoic acid dehydrogenase formed the subject-matter of an interesting paper by D K Basu and D P Burma, of the Bose Institute, Calcutta The enzyme, which was purified 60–70-fold, was found to be diphosphopyridine nucleotide-linked and specific for dihydrolipoic acid and its amide The reaction was irreversible when tested with lipoic acid as the substrate I S Bhatia and co-workers, of the Tocklai Experimental Station, Cinnemara, Assam, gave an account of their work on the transglycosidase present in tea leaves This enzyme reacted with maltose with the formation of maltotriose, maltotetrose and glucose With arabinose as the acceptor of glucosyl residues and maltose as the donor, a disaccharide containing glucose and arabinose was formed

The purification and properties of glutamic–oxalacetic transaminase from ox brain and from human brain were described by T N Pattabhiraman and B K Bachhawat, of the Christian Medical College, Vellore A 30–40-fold purification of the enzyme was achieved by fractionating the initial extract with alcohol, Zn^{++} and ammonium sulphate The purified ox-brain transaminase showed complete dependence on pyridoxal phosphate for its activity

A new type of enzymatic transamination reaction in which glyoxylate transaminates with a number of amino-acids to produce glycine was reported by L V S Sastry and T Ramakrishnan (Indian Institute of Science) *Iso*nicotinic acid hydrazide and L-penicillamine at low concentrations inhibited the enzyme but the inhibition was reversed by pyridoxal phosphate or metal The authors adduced unequivocal evidence to show that the transaminase was a metallo-enzyme The purification and properties of a naturally occurring inhibitor of glutamine synthesis present in *Pongamia* galls was described by N K Sukanya and C S Vaidyanathan (Indian Institute of Science) , they also showed the preponderance of this inhibitor in the gall tissue, as compared to normal tissue

N Appaji Rao, H R Cama and S A Kumar (Indian Institute of Science) gave details of some of their recent work on the occurrence of flavin nucleotides in plants and the changes in their concentration with germination of green gram (*Phaseolus radiatus*) and cow pea (*Vigna catiang*) The radicle of the germinating seedlings contained almost all the flavin adenine dinucleotide and the major portion of the total flavin, while the cotyledons and the plumules contained flavin mononucleotide as the major flavin Some interesting examples of species specificity in the mechanism of pyridine nucleotide synthesis by erythrocytes were reported by P G Tulpule, of the Nutrition Research Laboratories, Hyderabad Of the seven species studied by them only human and guinea pig erythrocytes were capable of synthesizing diphosphopyridine nucleotide from nicotinamide and glucose Human as well as monkey erythrocytes could also synthesize appreciable amounts of diphosphopyridine nucleotide from nicotinic acid and glucose in the presence of glutamine, whereas this metabolic pathway did not seem to operate in the guinea pig Red blood cells of the monkey were able to synthesize diphosphopyridine nucleotide only in the presence of glutamine, suggesting that nicotinamide was converted to nicotinic acid prior to incorporation in diphosphopyridine nucleotide

Four special lectures were given in the evenings on each day of the symposium Dr D. P Burma, of the Bose Institute, Calcutta, on "Pentose Phosphate Metabolism", Dr B K Bachhawat (Christian Medical College) on "Purification of Enzymes" , Dr P M Bhargava (Regional Research Laboratories, Hyderabad) on "Protein Synthesis" and Dr T Ramasarma (Indian Institute of Science) on "Coenzyme Q" P S Sarma

NATIONAL VEGETABLE RESEARCH STATION

NEW LABORATORY BUILDING

THE new laboratory building of the National Vegetable Research Station was officially opened on October 23 by H R H The Duke of Edinburgh

The decision to establish the Station was taken after the Second World War because of a continuing need to encourage vegetable production in Great Britain, and the Agricultural Research Council is now responsible for government grant-aid to finance the Station and for the general supervision of its scientific programme

The new building marks the culmination of ten years development from the time when the director, Dr J Philp, took over 280 acres of land at Wellesbourne, near Warwick, in September 1949 Initially the site had no electricity, roads or suitable water supplies, and the only buildings were three small cottages and a few farm buildings Building restrictions in the early years severely hampered development and the research staff had to be housed temporarily in old service huts, while Dutch light structures served as temporary glasshouses

The new laboratory building was designed by Mr F W Holder, chief architect of the Ministry of Agriculture, Fisheries and Food, and has a total floor area of 33,800 sq ft Besides laboratories and offices it contains a library, lecture room and committee room, and the basement has space for the future provision of controlled-environment chambers The construction uses pre-cast concrete frame and floors with external curtain-walling of insulated plastic and some brickwork, the roof being of copper The Station also has about a half-acre of glasshouses used for pot-experiments in research projects, a packing shed, implement shed, farm stores and buildings for livestock 170 acres are served by underground irrigation mains with a borehole for the water source

The site at Wellesbourne is central for the country as a whole and the soil and climate are suitable for vegetable production, being similar to those in the nearby Vale of Evesham, an important horticultural area The area of 280 acres, to which 95 acres have

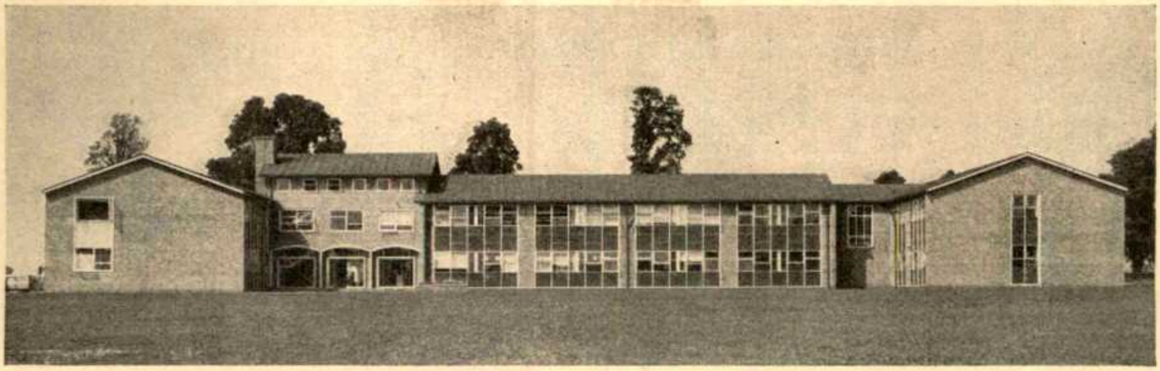

Fig. 1. New laboratories of the National Vegetable Research Station

recently been added, allows a farm unit to be run in conjunction with the experimental vegetable crops and is large enough to provide the isolation necessary for some of the research work. In addition, there is a sub-station at Paglesham, Essex, with an area of 150 acres, which is chiefly used for the multiplication of seed stocks.

All vegetable crops grown in the open and in cold frames, except potatoes, come within the purview of the Station, and its work is organized under eight sections: plant breeding; chemistry; physiology; irrigation; entomology; pathology; weed control; statistics.

Long-term experiments with a rotation of vegetable crops are now in their sixth year. The treatments comprise organic and inorganic fertilizers, time and frequency of application of nitrogen, and methods of soil cultivation. Growth studies are being made on some of the crops in these experiments to obtain information on the stages of growth most affected by fertilizers; the weed populations and soil-moisture characteristics of the soils under different cultivation methods are also being investigated. Dung has been shown to exert a marked influence on growth during the very small seedling stage.

Plant-breeding is carried on at a practical level with the production of improved varieties of vegetables, and at a more fundamental level with the application and development in vegetable crops of breeding methods as such. The method of inbreeding to attain uniformity followed by crossing to restore vigour, used so successfully in maize, has been applied to brussels sprouts, and hybrids with yields 40 per cent above the parent strains have been produced. The backcross technique is being used for the introduction of winter hardiness into an otherwise satisfactory quick-freeze variety of pea. In the diœcious species, asparagus, where the male plant is commercially desirable and usually heterogametic, isolation of homogametic male plants has produced strains giving all-male progeny on crossing.

Entomological research is mainly concentrated on the carrot fly, the cabbage-root fly and the lettuce-root aphid. Ecological work on the effect of insecticides on the balance between the cabbage-root fly and its predators has shown that the balance can be tipped in favour of the pest by indiscriminate broadcast application of insecticides. The use of insecticides against carrot fly raises problems of off-flavours in the crop and of the possible build-up of insecticides in the soil. Extensive testing tests have been carried out at the Station with carrots to assess the effect of insecticides on their flavour. A technique which has been developed for the assay of insecticide residues in the soil enables concentrations of dieldrin as low as 0·05 p.p.m. of soil to be measured.

The diseases of vegetable crops are as diverse as the crops themselves. The silvering disease of red beet, which is bacterial, has been successfully controlled with streptomycin. Fungal diseases include the long-known club root of brassicas and the relatively new crook-root disease of watercress; new fungicidal techniques give hope of controlling both these, while the prevention of virus diseases in watercress and lettuce is being sought through the production of clean stocks. The development of resistant varieties by selection and breeding techniques is being tried for parsnip canker and *Didymella* stem rot of tomatoes.

Work on the irrigation of vegetables has been primarily concerned with the most efficient use of water. Moisture-sensitive periods during growth have been found to exist with some vegetable crops, and at these periods irrigation has its maximum effect, while at others it does not produce an economic response. Work has been started on the relationship between water and nutrient uptake in the root system and on the use of additives to irrigation water.

The newer residual herbicides are being tested for suitability on a wide range of vegetable crops, and work has recently started on the nature and extent of the damage to vegetable crops caused by the drift of spray from herbicides used on neighbouring agricultural crops. The effects of weeds are also being studied in two other aspects: the unevenness of weed distribution has been shown to be partly responsible for field-plot variation in the yields of experimental crops, and the reduction in crop yields caused by weeds has been found to be affected by the spatial arrangement of the crop plants. Suitable mathematical models to describe the growth of some crop plants are being sought, with the view of improving the interpretation of treatment-year interactions in long-term experiments.

On the practical side, the Station maintains close links with the National Agricultural Advisory Service, and is fortunate in being able to make use of the experimental horticulture stations of this body for the further testing of experimental findings under a wider range of conditions. On the academic side, an arrangement with the University of Birmingham enables postgraduate work carried out at the Station to be recognized for the purpose of obtaining internal higher degrees of the University.

J. A. Nelder

THE GRASSLAND RESEARCH INSTITUTE

In the past, grassland has received much less than its due share of attention from the scientist, but some of the extensive work on this subject now being done in Great Britain is summarized in the recently published annual report for 1957–58 of the Grassland Research Institute (Experiments in Progress, No. 11. Pp. 108. Hurley, near Maidenhead: Grassland Research Institute, 1959. 7*s.* 6*d.*). Many aspects of the composition, treatment and use of grassland swards are investigated by the nine departments. The Department of Herbage Agronomy is concerned with management, yield and quality of herbage at all seasons of the year, and the emphasis has shifted from comparison of species and varieties to establishment and management of the sward. Continuation of the study of the relationship between white clover and top-dressings of nitrogenous fertilizer has shown that the effect of white clover on gross yield of herbage was equivalent to approximately 9 cwt. per acre of a nitrogenous fertilizer annually on a no-clover sward. The results of experiments with gibberellic acid showed that response to nitrogenous fertilizer at 4 cwt. per acre was greater than response to 2 oz. per acre gibberellic acid. Nitrogen plus gibberellic acid produced an additive effect at first, but in the presence of nitrogen there was a significant depression in yield as a result of gibberellic acid treatment; depression was greatest where the initial response to gibberellic acid was marked.

In the Section of Animal Agronomy, grassland production is measured in terms of the animal. Better live-weight performance per animal was obtained when cocksfoot was grown with lucerne than when lucerne was grown alone. A comparison of two methods of sowing and managing lucerne and cocksfoot indicates that it is possible to extend the grazing season by about four weeks in the autumn by use of nitrogenous fertilizers. The live-weight gain per acre of ewe lambs carried throughout the year at a stocking rate of 6·1 per acre was, on average, 65 lb. higher on swards containing white clover, although the grass swards received nitrogen to compensate. The comparative influence of leys, variously managed, on the yield of subsequent cereal and kale crops has been investigated by the Department of Ley Agronomy. It is demonstrated that management of ley swards has an appreciable effect on yield of the following crops. This is accounted for largely by the nitrogen status of the soil. The study of the intake and digestibility of herbage is one of the main concerns of the Department of Biochemistry and Animal Nutrition. This involves both feeding experiments and biochemical studies of herbage plants. The former have shown that certain of the major grasses are more digestible than others and the latter that the older methods of fractionation are too arbitrary; modern techniques are likely to give a more reliable assessment of digestibility.

The work of the Department of Plant Physiology is linked with that of Herbage Agronomy in laboratory and field. The detailed growth studies are likely to provide valuable guidance on grazing practice. Experiments in microbiology are connected to soil and herbage studies in other departments, with emphasis on the examination of the processes of decomposition which take place when the ley is ploughed. A small experiment on sterilization of grass by radiation suggests that it may be possible to preserve grass for several months without undue changes in palatability. Extra-mural experiments provide supplementary evidence over a wide variety of environmental conditions. Such experiments are usually done in collaboration with the National Agricultural Advisory Service. The Department of Biometrics provides statistical advice and a computing service for other departments and has commenced its own field-experiments to answer specific questions.

SCIENTIFIC RESEARCH IN ALBERTA

The thirty-ninth annual report of the Research Council of Alberta, covering the year 1958, stresses the work on ground water geology and the studies on the Precambrian Shield area of north-east Alberta (Report No. 78. Pp. 66. Edmonton: Research Council of Alberta, 1959). Work was commenced on the delineation of areas with large coal reserves which could be developed by industry as a source of power, and reconnaissance surveys were made of alkali lakes in Alberta and of the mountains west of Nordegg. A laboratory study of till from the Cooking Lake moraine showed that electrical potentials up to 0·5 V. can be generated in soil between individual horizons by natural processes. Soil surveys continued and a study is being made to determine the characteristics of the dominant parent materials of Alberta soils, the composition of the glacial till and the local variations. Further work at Youngstown showed that the productivity of the solonetz soils was limited by the physical condition of the soil, times and timeliness of irrigation being both critical under such soil conditions. The hail reporting network was further extended and valuable results were obtained in spite of an unusually low incidence of hail in the area. The highway research programme was largely concerned with the instrumentation and study of a five-mile portion of the trans-Canada highway west of Calgary, on which test sections of three different types of concrete pavement were laid.

Fundamental studies on coal in the organic chemistry laboratory included an examination of reactions of humic acids, a preliminary survey of the properties of kerogens and other organic substances associated with inorganic sediments, and substantial progress in the separation of the products obtained by oxidizing pyrolysed truxene with nitric acid. The main effort of the physical chemistry laboratory was in studies of the mechanism of thermal decomposition of coal and the control of the decomposition by gaseous and gas-entrained additives; but the effects of ultrasonic irradiation on small molecules were also examined and the viscosity characteristics of solvent extracts from coal and the shape and size of the extracted molecules In palæobotany, substantial progress was made in formulating means for identifying fossil spores and pollen grains, and the development of a 'key' for identifying living and fossil conifer woods is now virtually complete Further studies are reported on fluidized carbonization, and the first stage of a coal grindability investigation was completed In the petroleum division studies continued of the catalytic desulphurization of sulphur compounds at high temperatures to remove sulphur as hydrogen sulphide and on the oxidation of sulphur compounds to remove it as sulphate The study of two-phase flow of oil and water in pipe-lines was continued, in which a general mathematical analysis was developed for two immiscible fluids flowing between wide parallel plates and flowing concentrically in a circular pipe Considerable progress was made in the study of the effects of hydrogen isotopes on the rates of chemical reactions, while the study of the retention volumes of hydrocarbon gases on chromatographic columns of a series of activated charcoals has been extended to an examination of the relative widths of the chromatographic bands The autothermic surface combustion reactor for pyrolysing hydrocarbons was further developed A list of publications of the Council is appended

BIOLOGY OF *AMŒBA*

THE late Robert Chambers was a much-loved personality on both sides of the Atlantic A publication by the New York Academy of Sciences has been greatly influenced by him, many papers being presented by his former students and 'second generation' of students* The papers deal exclusively with the 'fission cycle' of the life-history of Amœba I first made acquaintance with Chambers when studying *Daphnia pulex*, each having worked out its spermatogenesis Later, I sent to him supplies of *A proteus* at various localities

An article by Mazia in "Science in Progress"[1] prepared readers for some of the many good things in this volume After a short biography of Chambers and an introduction by Hirshfield, the subject-matter is grouped into four parts In part 1 ("Structural and Taxonomic Considerations"), Torch describes the cytology of Pelomyxa The most interesting conclusion is that crystals are a metabolic waste product, probably an accessory mechanism for the excretion of nitrogen Particulates of Amœbæ are studied by Kassel using a drop-retraction technique , proteins on reaching an experimentally introduced oil–water interface unfold and produce a surface denaturation curve resembling that of a medium containing a protein of low molecular weight Useful practical hints and photographs of apparatus, as well as electron microscope studies, are given in "Microscopic Studies" by Borysko and Roslansky Beautiful electron microscopic work by Pappas reveals the astounding presence of fine fibrous extensions on the outer surface of the plasmalemma of three species of amœba, and other unsuspected structures Kudo gives a welcome résumé of the work of the early observers and their nomenclature and makes a strong plea for the retention of the name *Amœba* for the genus

In part 2 ("Physical Studies and Cell Division") Landau deals with sol–gel transformations in Amœbæ, and considers that the findings of myosin-like proteins in amœboid forms lend credence to the idea of a contractile substratum "Synchronization of Cell-Division" by James gives much fascinating detail of the observations made during the establishment of the main thesis Three authors describe pinocytosis, which was discovered by Lewis, and observed by Mast and Doyle in amœbæ, but only recognized as important in the past few years Holter, in the next paper, gives some beautiful pictures of the phenomenon, and stresses its importance in the physiology of amœboid cells, though he thinks that the original definition may require modification towards less emphasis on the fluid uptake and more on the dissolved substance

A very long paper of sixty-three pages by Guthwin and Kopac is a vade-mecum for the microscopic enzyme chemistry of carboxylic esterases in Amœbæ "Cytochemical Differentiation in Normal and Starving Amœbæ", by Heller, is the second article of part 3 An interesting analysis of the cytoplasmic inclusions deals with refractive bodies As I have repeatedly pointed out, these refractive bodies are nutritive, and for that reason Dr Carmela Hayes renamed them 'nutritive spheres' They play a great part in the formation of the spores in the Proteus group of Amœbæ Their diameter is indicative of the age of the Amœba—an individual with large nutritive spheres is old and ready to sporulate Cohen, in "Physiological and Morphological Observations", gives the first hint as to the great weakness of the work under review when he says, "*A proteus* in our experience consists of at least two strains investigators should give the history of the stock they use" I maintain that two distinct species masquerade under the specific name *proteus* I have had an opportunity of studying a rich culture from the laboratory of Brachet it was *A lescherae* and not *A proteus* It also contained very young stages of development, proving that even under rigid subculturing a few individuals escape and sporulate Want of space prohibits more than mention of "Tracer Studies in Amœbæ" by Plaut, "Effect of Selected Chemical Agents on Amœbæ" by Zimmerman

In part 4 Hirshfield discusses "Nuclear Control of Cytoplasmic Activities" and Prescott pictures the wonderful Cartesian diver for weighing Amœbæ in his article on microtechnique in amœbæ studies "Micrurgical Studies on Irradiated Pelomyra", by Daniels, is followed by an account of the celebrated work of Danielli on strains of Amœbæ that have been continuously cultivated for years in King's College, London In conclusion, one would urge the examination of older Amœbæ for the presence of deoxyribonucleic acid Brachet's beautiful work on the "Cytoplasmic Dependence in Amœba" evidently omits this The volume ends on a lighter vein when Kopac visualizes Amœba research in 2158 Used in conjunction with Jepps's "The Protozoa, *Sarcodina*"[2], this volume is a useful reference book for all students of *Amœba* MONICA TAYLOR

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* Annals of the New York Academy of Sciences Vol 78, Art 2 The Biology of the Amœba By Henry I Hirshfield and 22 other authors Pp 401–704 (New York New York Academy of Sciences, 1959) 4 50 dollars

[1] "Science in Progress", edit by Taylor, Hugh, 10th Series (New Haven, Yale)

[2] Jepps, M W , "The Protozoa *Sarcodina*" (Oliver and Boyd, Edinburgh, 1956)

VALUE OF CONTOUR ANALYSIS IN EQUATORIAL METEOROLOGY

By D. H. JOHNSON and D. H. T. MORTH
East African Meteorological Department, Nairobi

SINCE November 1958, daily contour analyses have been made at the East African Meteorological Department, Central Forecast Office, East Africa, for standard pressure-levels from the surface to 100 mb., and for an area which includes all Africa, and Europe to 55° N. Such analyses are believed to be unique for Africa: they are giving an insight into mechanisms governing equatorial weather which has not been provided by conventional streamline analyses of the upper winds.

Flow and changes in the flow are as dependent in the tropics as elsewhere on the pressure field and its evolution. However, the want of radiosonde data, lack of success in explaining day-to-day variations in weather in terms of the surface pressure field, and the absence of a fixed relation between pressure gradient and wind, have led to a concentration in the past decade on streamline analysis alone. Streamlines define usefully the instantaneous wind but they have failed in everyday use in East Africa to account satisfactorily for the observed weather, and they have contributed little by themselves to the solution of forecasting problems. Improvements in radiosonde and radar wind coverage over Africa, due largely to the stimulus of the International Geophysical Year, now permit some deductions regarding the role of the upper pressure distribution to be made.

Principal points of contrast with middle-latitude upper patterns are: (*a*) equatorial pressure gradients are weak, a consequence of the inability of other terms in the equations of motion to balance a large pressure force in the free atmosphere; (*b*) pressure systems which influence East African weather are slow-moving or stationary and weather changes are effected more often through development *in situ* than by travelling disturbances.

Though the observations are still insufficiently dense and accurate to define the contours precisely, certain characteristic states have been recognized. An important case arises when upper anticyclones in the lower latitudes of each hemisphere are separated by a trough along the equator (Fig. 1). This system is associated with zonal flow. Pressure gradients and winds derived by assuming a geostrophic balance agree well with observations. When the contours are confluent as in the right of Fig. 1, acceleration leads to convergence near to the equator, and if the convergence extends in depth through the lower layers, a rain-producing mechanism exists. Understandably, the most marked effects on the weather occur when the pressure field is not stationary, but either or both of the anticyclones change their intensity or location; the accelerations are then potentially greatest since the geostrophic balance is particularly delicate due to the smallness of the Coriolis parameter.

A second well-defined model occurs when a meridionally directed pressure gradient exists across the equator (Fig. 2). The geostrophic departure increases as the equator is approached and the unbalanced pressure force at the equator itself leads simply to down-gradient (Eulerian) flow: the contours are crossed perpendicularly by the streamlines a few degrees downstream of the equator, the lag being due to the zonal momentum carried. This model was observed primarily in the period January–March 1959 when, in the lower troposphere, the low pressure to the south took the form of a zonal trough. Cochemé[1] has remarked on the predominance of this pattern near the surface during February 1955 and has noted the resemblance to the large-scale monsoon flow associated with the Indian summer low pressure. On other occasions the low pressure is the equatorward portion of a large-amplitude trough in the polar westerlies which has penetrated the subtropical anticyclonic belt. This pattern was typically associated with lower divergence and fine weather north of the equator and with rain in the convergent westerlies to the south.

The foregoing two cases have been illustrated in simple form, but smaller-scale complications, some orographic, some developmental, may be superimposed upon them, and the two patterns can co-exist in adjoining longitudes. Other characteristic states arise. Of particular importance are those which give rise to westerlies in the lower half of the troposphere. East African meteorologists have long recognized an association between westerly winds and widespread rain. Previously this has been ascribed to the presence of a source of moisture to the west. We observe, however, that a more than adequate supply of moisture is carried inland in the lower layers of the easterly monsoon currents, and consider this to be the more important moisture source for East African rainfall. Westerly flow is often simply

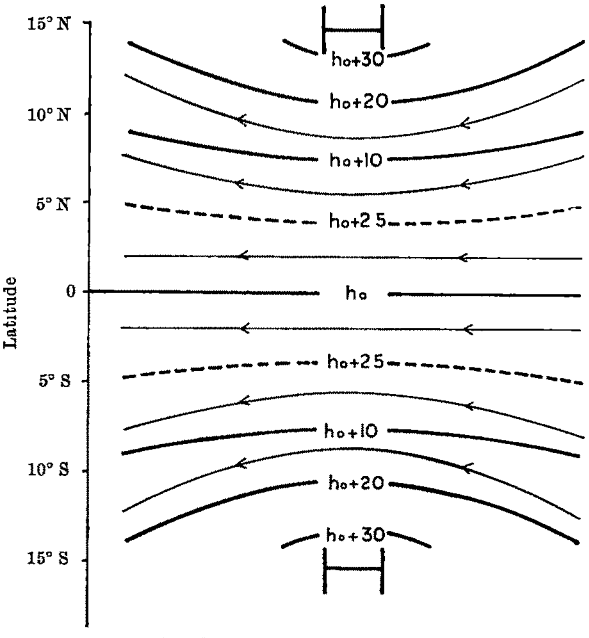

Fig. 1. Equatorial duct. —, Contour line (height in m.); —←, streamlines

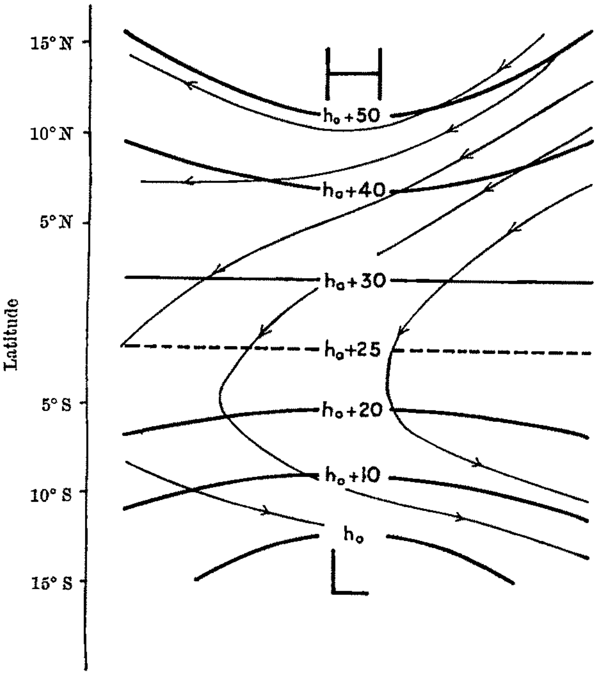

Fig 2 Cross-equatorial drift —, Contour lines (height in m), →—, streamlines

a recurving easterly monsoon current. A basic tendency for moisture to be contained in the lower layers in easterlies, due to subsidence, and for upward transport of the moisture in westerlies, is ascribed to the operation of the Coriolis term, $2\Omega\cos\varphi\, u$, in the equation for the vertical acceleration

$$\frac{dw}{dt} = -\alpha\frac{\partial p}{\partial z} - g + 2\Omega\cos\varphi\, u$$

where the symbols have their conventional significance. Considering a fixed value for u, the term $2\Omega\cos\varphi\, u$ has its maximum at the equator. It has usually been dismissed as being negligibly small[2] in comparison with the pressure gradient and gravity terms, but these oppose each other, being approximately in balance. In these circumstances smaller terms can achieve significance. Calculation of the last term shows that, providing the possible compensating mechanisms only partially diminish the instantaneous acceleration, appreciable vertical motions could build up on the time-scale of synoptic processes. The effect is by no means over-riding and may be opposed or enhanced by the synoptic situation.

The importance of examining pressure and flow patterns at several levels of the lower troposphere when assessing the significant vertical motions was amply demonstrated during May 1959. Marked low-level divergence over Kenya and Tanganyika, in the outflow from the surface/850 mb Mauritius/Madagascar sub-tropical anticyclone, underlay on different occasions a confluent 700 mb pattern (Fig 1) and a weak westerly flow, in both cases no rain fell.

As recently as December 1958, the opening speaker at a Meteorological Office discussion on tropical meteorology[3] remarked that the forecasting of upper winds from prontours is invalid in equatorial regions because a relationship between contours and wind has not been established. Contrariwise, the present work, which raises hopes of a basically synoptic solution to East African weather forecasting problems, suggests that the ability to predict changes in the contour pattern in low latitudes is a fundamental need. We most strongly disagree with the view expressed by Walker in the same discussion[3] that there is no guarantee that an improved upper air network would improve (equatorial) forecasting significantly. In a paper which has very recently come to hand, Palmer and collaborators[4] have proved the occurrence of approximately geostrophic flow down to equatorial latitudes in the Pacific Trades, their investigation demonstrates most eloquently the value of a close homogeneous network of radiosonde and radar wind observations in solving the problems of equatorial flow. the establishment of a similarly close network in East Africa and adjoining territories, where a greater variety of pressure patterns and far more synoptic change occurs, would, we contend, lead to fundamental progress in our understanding of equatorial weather mechanisms.

We wish to thank Mr B W Thompson, regional meteorological representative, Kenya, East Africa, for his constant support and advice, and Mr J P Henderson, director, East African Meteorological Department, for permission to publish this account.

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PERMANENT MOISTURE EXPANSION OF CLAY PRODUCTS ON NATURAL EXPOSURE

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THE criticisms by Vaughan and Dinsdale[1] of our communication[2] on the progressive long-term moisture expansion of clay products, and their objection to our use of the term 'permanent' to describe it, lead us to fear that they still regard the problem as one of academic interest only and not as a serious practical one, such as our observations of damage to buildings in Australia[3] and those of McBurney[4] in the United States of America have shown it to be. Although the expansion may apparently be removed by subjecting the materials to high temperatures, it is permanent at atmospheric temperatures, and hence as long as we are considering the problem as a practical one

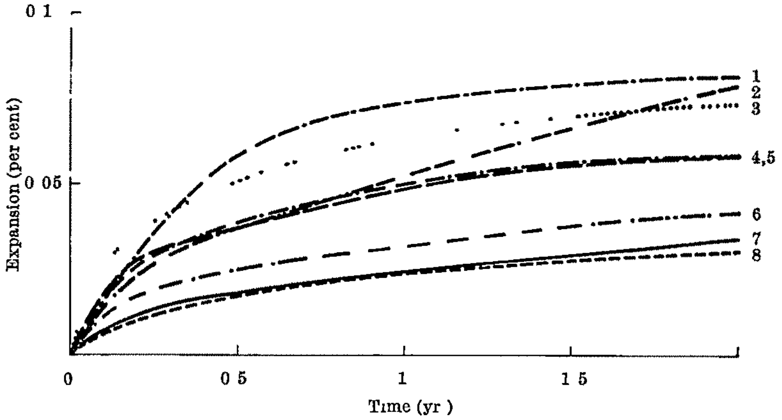

Fig. 1. Average permanent moisture expansion curves for eight types of clay product on standing in air for two years. Curve 1, roofing tiles; curve 2, wall tiles; curve 3, architectural terra-cotta; curve 4, bricks; curve 5, china body; curve 6, refractory body; curve 7, floor tile; curve 8, firebrick

the expansion can properly be referred to as permanent.

Our main object in studying the problem is to determine, for a wide range of clay products, the ultimate expansions and the times taken to reach these, whether they be 50, 100 or 1,000 years. A knowledge of both is necessary if we are to find out how to offset the expansion and so prevent the resultant damage. The reason that we, like others, have autoclaved the bodies in steam has been to accelerate the process of expansion and thus to study, in a reasonable time, the reactions which normally take a life-time or more. Unlike others, however, we have continued the process of autoclaving until the bodies reached dimensional stability and have thus obtained measures of the maximum expansions the bodies suffer at high temperatures. At the same time, we have not neglected to observe the bodies under natural conditions, for it is only thus that the practical behaviour of the bodies can be correlated with the results at high temperatures.

In all, we now have more than a thousand industrial and laboratory specimens exposed under natural conditions, and these are being added to from time to time. Replicate samples are exposed, out of doors, in an air-conditioned laboratory and in an atmosphere of 100 per cent relative humidity, while others are kept totally immersed in water; others again have been subjected to cycles of soaking in water and drying at 110° C. Some bricks have now been under observation for five years, at the end of which time they show expansions ranging from 0·045 to 0·20 per cent with an average rate still between 0·005–0·006 per cent per annum. Most products have been under observation for shorter periods, and the average and range of the expansions for the eight types of body for which results on autoclaving have already been reported[2], after standing for two years either in the laboratory or out of doors, are given in Table 1. Curves for the average expansion of the products with time are given in Fig. 1. Because of the small number of some of the products so far examined the values cannot be considered as completely characteristic, but they do indicate the general trends for the various bodies.

Our results show that the expansions on standing in air are higher than those predicted from the temperature coefficient of the expansion process based on high temperature data[2], and from this and other observations it is clear that there are no practical relationships between autoclave and low-temperature data[3]. Estimates of ultimate expansions likely in practice and the times to reach these have therefore to be based on the results obtained for natural exposures to date, and as they come to hand in the future.

From our experience we are not surprised that specimens used by Vaughan and Dinsdale did not reach equilibrium during relatively short periods of either natural exposure or autoclaving. Standing for three years is a long way short of the periods for which we know that bodies can continue to expand[3], and calculations based on the temperature coefficient of the expansion process[2,3] show that times of the order of 12,000 hr. would be required if the bodies are to reach dimensional stability in steam at 50 lb./sq. in.

We have observed shrinkages on drying as reported by Vaughan and Dinsdale only in under-burnt bodies, and then only on drying after more than one cycle of wetting and drying; these shrinkages are, however, always less than the original expansions on wetting. Normal ceramic bodies have, in general, continued to expand on drying at 110° C whether they have been soaked in water or treated in the autoclave[3]. This has also been the experience of other workers[5], and Bonnell and Butterworth[6] have found that no less than 50 per cent of the bricks of the United Kingdom expanded when tested for drying shrinkage. Only when specimens have been autoclaved until they approach dimensional stability (far beyond the stage to which Vaughan and Dinsdale's specimens were taken) do drying shrinkages become apparent, and then only of the order of 0·01–0·02 per cent, a mere fraction of the total expansion. In this connexion it is of practical significance that all nine experimental walls which have now been standing for more than three years at this Division expanded at slightly higher rates when drying out during the hot summer months[3]. The explanation for this is simple: it is due to the increased rate of reaction between the reactive compounds in the bricks and the water still present at the higher temperatures during the drying out process.

Vaughan and Dinsdale's observation that a complete reversal of the change in size can be obtained by heating to 300° C suggests that they have not investigated a very wide range of bodies. This

Table 1. PERMANENT MOISTURE EXPANSION FOR EIGHT TYPES OF CLAY PRODUCT STANDING IN AIR

Product	No. examined	Expansion	
		Average (per cent)	Range (per cent)
Roofing tile	94	0·082	0·162–0·009
Wall tile	18	0·079	0·094–0·066
Architectural terra-cotta	12	0·074	0·098–0·059
Brick	260	0·061	0·186–0·010
China body	6	0·061	0·110–0·034
Refractory body	6	0·042	0·080–0·023
Floor tile	12	0·034	0·080–0·014
Firebrick	12	0·031	0·045–0·020

phenomenon has been reported once before[7], but most other workers have found that temperatures of at least 600° C and often much higher are necessary for this purpose[8] In some cases it has proved impossible to remove expansion without heating to temperatures approaching and above those at which the specimens were originally fired At these temperatures further firing shrinkages occur and the two effects become confused , this suggests that even at lower temperatures the shrinkages obtained by reheating are not necessarily caused by a reversal of the expansion process, and hence any approximate numerical agreement may be quite fortuitous

Our critics also raise the question of expansion taking place during the cooling of the clay bodies in the kiln, and its effect on the establishment of a standard zero of measurement We are fully aware of this problem but do not see that their proposal of a preliminary desorption is of practical value The specimens will still have to be cooled after this treatment before they can be measured, and hence they will again adsorb moisture, and further, as we have pointed out above, most bodies if heated after they have adsorbed moisture expand still more We therefore consider that the small amounts of expansion in the kiln must be disregarded from the practical point of view What matters is the expansion that takes place in the structures into which the units are built, and therefore the practical basis for calculating and comparing expansions is the ex-kiln length of the products

From experimental evidence in this Division[2,3,9] we consider that chemical processes involving hydration of such constituents as amorphous alumino-silicates, glasses and amorphous silica are responsible for expansion, and that reversible physical swelling, except in under-burnt bodies, plays a very minor part Furthermore, we consider that the evidence presented by our critics does not substantiate a physical explanation

A full account of our work to date on bricks[3] is now available and we hope to present a summary of current studies on the expansion (under natural conditions of exposure) of all clay products examined so far to the seventh International Ceramic Congress in 1960

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EXISTENCE OF AN INNER AURORAL ZONE

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FROM theoretical considerations Alfvén[1] predicted the existence of an inner auroral zone at a polar distance of 5–10° Nikolsky[2], Meek[3], and others have found that the maxima of geomagnetic and ionospheric disturbances are concentrated around a spiral-shaped zone which Nikolsky identifies with the inner auroral zone However, no observation of auroræ in relation to this zone seems to have been made , the spiral-shaped zone is presumably identical with the curve of geographical distribution of maxima of magnetic activity of class J[4] At Godhavn (69 2° , 306 5° geog) this class of activity is not at all, or very poorly, correlated with auroræ , hence the zone of Nikolsky, Meek and others can scarcely be regarded as an auroral zone in the proper sense

It is the purpose of this article to direct attention to a 'population' of auroræ which seems to form an inner auroral zone , it summarizes a study which was presented in part at the Auroral Conference at Uppsala in August 1958 A more detailed paper will be published elsewhere

As a result of visual auroral observations at Godhavn during 1952–56 it was found that the diurnal distribution of auroral frequency there had two maxima In fact, the distribution is composed of two distributions of different types One, with a maximum near magnetic midnight, is formed by relatively brilliant auroræ, approaching and sometimes passing zenith from the south-east, accompanied by negative magnetic bays These auroræ are especially frequent and brilliant on international disturbed days and in years with low sunspot activity

The second distribution with a maximum at about 6h local time is formed by zenithal auroræ These are narrow diffuse bands, sometimes with a faint ray structure, or draperies—often several parallel draperies—composed of long rays that may be at some distance from each other The draperies may form fans or coronas, occasionally accompanied by colour effects, but generally the movements of the arcs and rays are very moderate They may rather be described as slow pulsations of intensity , narrow homogeneous arcs slowly die away, while parallel arcs a few degrees from them grow in intensity These slow variations may go on for a long time , they seem quite irregular and not in phase in the different arcs or rays, so that the mean position of the aurora is little affected by the intensity variations

Several authors have assumed that the main auroral zone is displaced polewards in the morning hours There is no observational evidence that this is the reason why auroræ are observed at Godhavn in the morning hours On the contrary, in the cases where the onset of the morning-type auroræ was observed, very weak auroræ began sporadically at a great elevation at about 3h –4h (Ascagrams from the International Geophysical Year, too, show that the auroræ begin suddenly within a few degrees from Godhavn) The mean elevation did not change significantly in the course of the morning , the mean distribution of the elevation of the arcs and draperies had its maximum a little to the south of zenith (Fig 1)

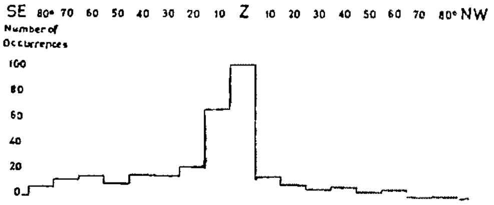

Fig. 1. Frequency-distribution of zenith-distances, Godhavn, 1954–56

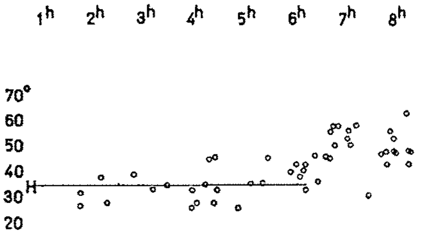

Fig. 2. Azimuth of arcs, Godhavn, 1954–56

The direction of the bands was perpendicular to *H* until 6h; at about 6h the mean direction suddenly changed in a clockwise sense (as seen from above). The change is consistent with Alfvén's theory[5]. The order of magnitude was 20° in 1954–56 (Fig. 2).

Whereas the evening-type auroræ are strongly related to magnetic activity, the morning-type auroræ are not correlated with local magnetic activity, and they appear to be independent of the planetary state of disturbance, too. Thus, observations from Upernavik, a few degrees to the north of Godhavn, from the years 1884–1937, show that auroræ noted at 21h L.T. were eight times as frequent on international disturbed days as upon international quiet days. Auroræ noted at 8h were here, as well as at Jakobshavn, a hundred kilometres to the east of Godhavn (observations 1885–1915), distributed at random between quiet, disturbed and the remaining days. At Godhavn auroræ were observed on 106 of a total of 110 clear mornings without moonlight in the winters 1954–55 and 1955–56.

A study of published auroral reports from arctic expeditions has shown that the morning-type auroræ observed at Godhavn can be found at several other locations too. Thus the auroral type mentioned was observed near zenith at Kingua-Fjord[6], and it seems likely that the same was the case at Chesterfield[7,8], Coppermine[7] and Murchison Bay[9]. Further, auroræ near zenith in the morning hours were observed at Danmarkshavn (76.5°, 341°), Station Nord (81.5°, 342°) and at a number of stations on the western coast of Greenland not very distant from Godhavn (unpublished observations, Danish Meteorological Institute).

To the south of Godhavn the auroræ seem to have been observed from Godthåb, whereas at stations in southern Greenland nearer to the main auroral zone this type of aurora has not been identified.

At stations nearer to the centre of the auroral isochasms (Peary Land, Upernavik, Thule) the morning auroræ are observed less frequently and mainly on the southern sky (unpublished observations).

In the Antarctic the inner zone auroræ were observed by several expeditions, for example, by Mawson at the stations Cape Royds and Cape Denison[10].

On the map in Fig. 3 (after Hultquist[11]) the places at which the morning auroræ are observed near zenith have been plotted as circles. They are seen to form a zone which is practically coincident with Hultquist's auroral isochasm through Godhavn. This oval, which is the projection of a circle in the equatorial plane outside the Earth on to its surface along the geomagnetic lines of force, may thus be regarded as an inner auroral zone, occupied in the early morning- and day-hours of all days, irrespective of disturbances in the main auroral zone.

Fig. 4 shows the diurnal distribution of auroral frequencies for December and January 1948–50 at five stations in Greenland. The stations are Thule

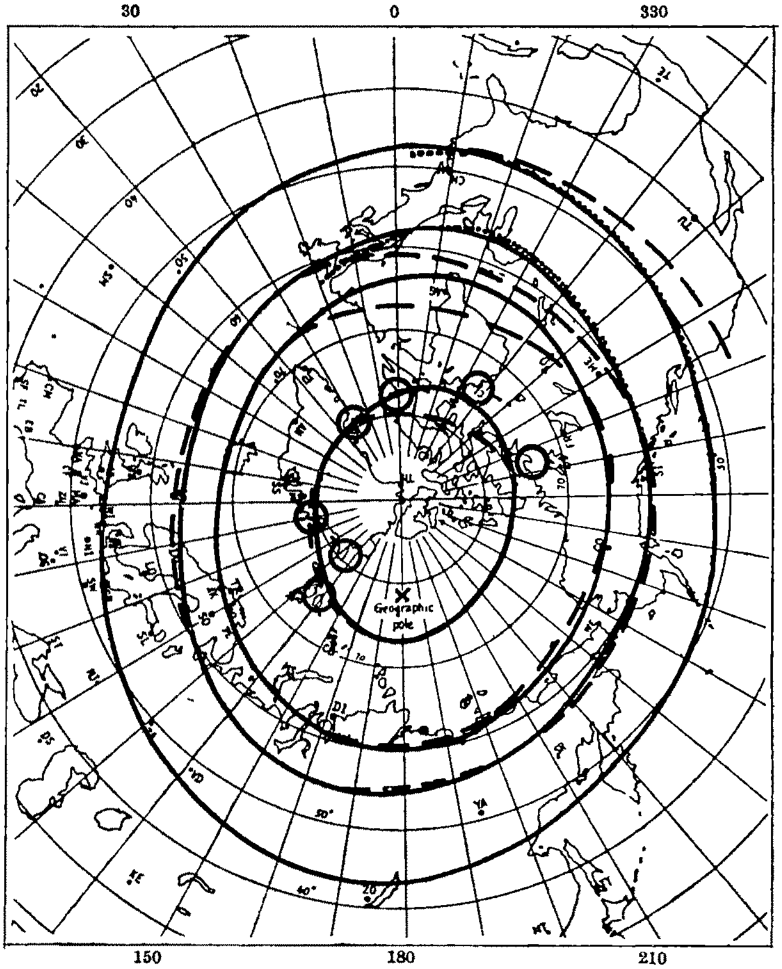

Fig. 3. Auroral isochasms (after Hultquist) and stations with morning auroræ near zenith

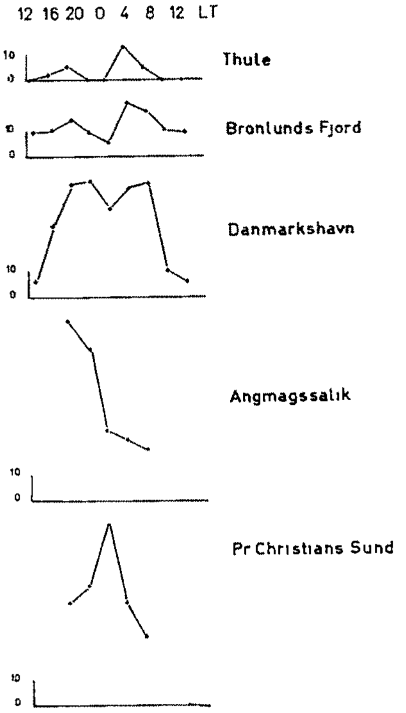

Fig 4 Percentage of clear hours with aurora at five stations in Greenland, December and January 1948–50

(76° 33′ N , 68° 49′ W), Brønlunds Fjord, Peary Land (82° 10′ N , 30° 30′ W), Danmarkshavn (76° 46′ N , 18° 45′ W), Angmagssalik (65° 36′ N , 37° 33′ W), and Prins Christians Sund (60° 03′ N , 43° 12′ W) The figure gives the percentage of clear hours with aurora, arranged according to local time , the same scale has been used at all stations Whereas the frequency of evening auroræ increases from Thule to Angmagssalik–Prins Christians Sund it is clearly seen that the frequency of the morning auroræ has its maximum at Danmarkshavn, in accordance with the idea of the existence of an inner auroral zone there

Hulburt[12], in his study of the diurnal variation of auroral frequencies, takes the view that "Vegard's conclusion, that most auroral forms show an evening and morning maximum, is contradicted almost as often as it is upheld" From Fig 4 (which is in agreement with material from several other stations) it may be seen that the different types of diurnal distributions can be arranged according to the following scheme (*a*) stations at the main auroral zone have distributions with a single maximum near geomagnetic midnight , (*b*) stations between the zones have often, in addition, a weak morning maximum , (*c*) stations near the inner auroral zone show two maxima, one near geomagnetic midnight and one at about 6h L T , (*d*) stations some degrees of latitude nearer to the pole show a weak geomagnetic midnight maximum and a distinct morning maximum

Great ionospheric disturbances begin at the same time as the onset of the morning auroræ The *F*-layer is dissolved into spread *F* and oblique incidences, which are soon accompanied by sporadic layers of auroral type at different virtual heights between the *E*- and *F*-layer heights Whereas observations of auroræ are restricted by cloud and daylight, a study of ionospheric disturbance is possible at any time The occurrence of ionospheric disturbance may be represented by the mean daily distribution of the frequency of $E_s > 3$ Mc /s , which is published monthly by the National Bureau of Standards By combining the frequencies for 3h–8h L T for the years 1952–56 it was found that the yearly variation of the morning disturbances is a single wave with a maximum at midwinter and a minimum at midsummer The variation through the whole period seems to indicate a variation in phase opposite to the sunspot variation

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ISOMERS OF VITAMIN A IN FISH LIVER OILS

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WE have investigated the occurrence of the '*iso-a*' and '*iso-b*' isomers of vitamin A in a number of fish liver oils by means of reaction with the retinal protein, opsin These isomers were found to constitute about 20 per cent of the vitamin A in cod, shark and mixed fish liver oils examined Since the presence in fish liver oils of all-*trans* vitamin A and neovitamin A (*neo-a*)[1] has previously been reported, all four of the 'unhindered' isomers have been found in these oils

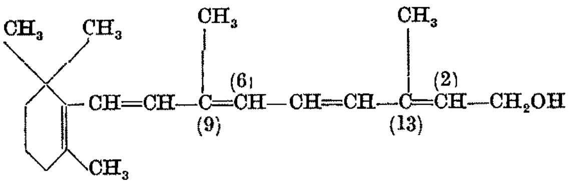
The finding assumes importance because the *iso-a* and *iso-b* isomers have only about one-fourth the growth-promoting activity of all-*trans* vitamin A, as measured by rat bioassay[2]

Nomenclature, structure and biopotencies for the *iso-a* and *iso-b* isomers are shown in Table 1

The trivial names devised by Hubbard and Wald[3] are used in this report because official action on a numbering system has not yet been taken The numbering systems now used include (*G*) Table 1,

Table 1

Trivial name	Stereoisomeric form		Relative biological potency (ref 2) (per cent) Vitamin A acetate	Vitamin A aldehyde (retinene)
	all-*trans*		100	91
	C	*G*		
iso-a	9-*cis*	6-*cis*	21	19
iso-b	9,13-di-*cis*	2,6-di-*cis*	24	17



the Geneva system used by *Chemical Abstracts*[4] and employed in earlier[2,5] and forthcoming papers from the Distillation Products Industries Laboratories and (*C*) the system analogous to that used with the carotenoids and employed by Wald, Brown, Hubbard and Oroshnik[6]

Hubbard and Wald[7] first reported the presence in a concentrate from fish liver oils of a *cis*-isomer of vitamin A different from the neovitamin A found by Robeson and Baxter[1] Later studies by Hubbard and Wald[3] on pure retinene (vitamin A aldehyde) isomers synthesized in the Distillation Products Industries Laboratories[5,8] showed that the isomer in fish liver oil was *iso-a* vitamin A The basis for the identification was the observation that both *iso-a* retinene and the retinene corresponding to the *cis*-isomer formed the same pigment with opsin, namely, *iso*rhodopsin, having an absorption band maximal at 487 mμ *Iso-b* retinene, on incubation with opsin, slowly isomerizes to *iso-a* retinene and forms the same pigment

This reaction was afterwards developed by Hubbard, Gregerman and Wald[9] as an analytical method for determining the *iso-a* and *iso-b* isomers in the absence of *neo-b* retinene The *neo-b* isomer, the key isomer in the visual process, interferes in this reaction by yielding the pigment rhodopsin, absorbing at 500 mμ The interference from *neo-b* retinene has not complicated studies on fish liver oils because this isomer has not yet been found outside the eye[10]

The results of applying this analytical procedure and an infra-red method to vitamin A preparations are given in Table 2

Four fish liver oil preparations (shark 'non-sap', that is, the non-saponifiable fraction, before and after concentration by molecular distillation, cod 'non-sap' and the 'non-sap' from distilled cod liver oil) were prepared (by M H S) and assayed by the opsin method (P S B) The test samples were saponified and the vitamin A isomers were recovered by extraction (U S P XV method) Sterols were separated by crystallization from methanol at −20° C The isomers were oxidized to the retinenes by procedures similar to those of Wald[11] with manganese dioxide prepared according to Henbest, Jones and Owen[12] The cod liver oil was a pharmaceutical preparation from an apothecary, the shark liver oil was from a bulk commercial shipment obtained at Distillation Products Industries Table 2 shows that 19–26 per cent of combined *iso-a* and *iso-b* isomers were present in the vitamin A of the oils

After further refinement of the procedures, the vitamin A of a pharmaceutical grade, mixed fish liver oil (sample 5, Table 2) was found to contain 19 per cent combined *iso-a* and *iso-b* isomers

The content of combined *iso-a* and *iso-b* vitamin A in a sample of oil from rat livers (sample 6, Table 2) was examined The value found (14 per cent) was lower than that found for the fish liver oil preparations examined, but was substantial and indicates that these isomers occur in other oils besides fish liver oils

The origin of the *iso-a* and *iso-b* isomers in fish liver oils is uncertain Ames, Swanson and Harris[13] have suggested, on the basis of bioassays of rat liver oils, that the isomers originate there from *in vivo* isomerization of all-*trans* or neovitamin A to form an equilibrium mixture A similar isomerization may occur in fish liver oils

Another possibility is that the '*iso*' isomers may sometimes be formed during processing of fish livers Lambertsen and Braekkan[14], for example, have reported evidence suggesting that neovitamin A is formed from all-*trans* vitamin A during commercial processing and it is possible that '*iso*' isomers may also be formed Pharmaceutical grade oils were used in the present study, where available, to ensure that the samples used had received as careful commercial processing as possible

The saponification and oxidation procedures used in the present work to prepare the samples for assay were examined as a source of isomerization Control experiments in which all-*trans* vitamin A palmitate was so processed produced negligible amounts of '*iso*' isomers, as measured by the infra-red procedure, and ruled out this possibility

The recognition of the prevalence of the *iso-a* and *iso-b* isomers made it of interest to isomerize samples of retinene *in vitro*, with dilute hydrochloric acid, until they had attained a state of 'equilibrium', defined as the point at which further exposure to acid produced no change in the proportion of the four isomers present Assays by the opsin and infra-red methods are reported in Table 2 As in fish liver oils, the proportion of combined *iso-a* and *iso-b* isomers in the vitamin A of the artificial iso-

Table 2

Sample No	Description*	Percentage *iso-a*+*iso-b* in total vitamin A isomers (opsin assay)	Percentage *iso-a*+*iso-b* in total vitamin A isomers (infra-red assay)
	Liver oil concentrates		
1	Shark 'non-sap' $E(1\%, 1\text{ cm})$ (328 mμ) = 538	24	—
2	Shark distilled 'non-sap' $E(1\%, 1\text{ cm})$ (328 mμ) = 628	26	—
3	Cod 'non-sap' $E(1\%, 1\text{ cm})$ (328 mμ) = 202	19	—
4	Distilled cod 'non-sap' E(373 mμ) = 427	25	—
5	Mixed fish liver oil 'non-sap' E(373 mμ) = 350	19	—
6	Rat liver oil† 'non-sap' E(370 mμ) = 270	14	—
	'Equilibrated' retinene isomer concentrates		
7	E(372 mμ) = 1,030	21	18
8	E(377 mμ) = 1,260	23	22
9	E(374 mμ) = 1,080	20	21

* The vitamin A in samples 1–6 was oxidized to retinene by manganese dioxide prior to assay

† Oil was a portion of that kindly supplied by Dr T K Murray, Food and Drug Directorate, Ottawa, Canada, for related bioassay studies

merates was about 20 per cent. The assays were run independently and the results indicated that with preparations of the purity investigated the two methods are in good agreement.

The average ratio of *iso-a* : *iso-b* isomers in the equilibrated samples was found to vary from about 2 : 1 to 4 : 1. This variability is probably caused, in part, by errors in measuring the relatively small amounts of *iso-b* isomer present.

Further information on the experimental methods is as follows.

Opsin. Opsin was prepared in digitonin solution, using a modification of the procedures described earlier[3,9,10]. This procedure will be reported in detail separately.

The essential steps in this procedure included dissection of retinæ from cattle eyes in the light, disintegration of the tissue by grinding, floating out the fragments of outer segments of the rods by differential centrifugation in phosphate buffer weighted with 40 per cent sucrose, lyophilization of the rod fragments, and exhaustive extraction of the dry powder with petroleum ether to remove extraneous lipids and vitamin A, and finally the extraction of opsin from the residue with 2 per cent aqueous digitonin. Such preparations were assayed for their opsin content with *neo-b* retinene (ref. 10). They were stored at about −15° C. until used for assay. They remained stable for many months.

Assay of retinene isomers. Samples of the mixed retinene isomers in a few drops of ethyl alcohol were pipetted into 2–3 ml. of 2 per cent digitonin in water. A cloudy solution usually resulted, depending on the concentration, but this was cleared by filtering through a fine sintered glass filter. The final solutions used for assay contained 5–10 μgm. of retinene.

Such solutions were assayed with opsin for their combined content of *iso-a* and *iso-b* isomers, as described for the assay of opsin itself, except that at least three times the equivalent amount of opsin was used in the determination. The photosensitive pigment formed in all experiments was *iso*rhodopsin (λ_{max} = 487 mμ), not rhodopsin.

Iso-a retinene combines directly with opsin to form *iso*rhodopsin. *Iso-b* retinene slowly isomerizes to *iso-a*, and hence forms the same pigment. With *iso-a* retinene, this synthesis is complete in 2 hr. at 23° C., whereas with *iso-b* retinene the same process is completed only within about 24 hr.

One therefore incubates an unknown mixture of retinene isomers with excess opsin, and measures the amount of *iso*rhodopsin formed at 23° C. in 2 hr., and in 24 hr. The amount formed in 2 hr. is primarily formed from *iso-a* retinene; that formed in 24 hr. measures the combined amounts of *iso-a* and *iso-b* retinene. A small correction of the 2-hr. value is needed to take care of the very small amount of *iso*rhodopsin formed from *iso-b* retinene during this period; the 24-hr. value is also corrected for the very small, almost negligible, synthesis of *iso*rhodopsin by the isomerization of all-*trans* and *neo-a* retinene during the incubation period.

Total retinene. The total amount of retinene in the samples was estimated by the antimony chloride reaction and recorded with a Cary recording spectrophotometer. The amount of retinene is determined on the basis that this blue product has *E*(1 per cent, 1 cm.) (664 mμ) = 3,740. From this and the preceding data, the percentage of combined *iso-a* and *iso-b* retinenes in the total retinene is computed.

Infra-red procedure. This work (by W. P. B.) was based on the curves for the individual retinene isomers already reported[5]. The percentage of combined *iso-a* and *iso-b* retinenes in the mixed retinene isomers is calculated from the absorption at 8.73μ, corrected for interference from the all-*trans* vitamin A and neovitamin A present by the absorption at 8.48μ.

The infra-red method has the advantage over the one employing opsin, that it can be used to determine the percentage of each of the four isomers in the sample, although we describe here only its use in determining the percentage of *iso-a* + *iso-b* isomers present. It has the disadvantage that the retinene content of the sample needs to be relatively high, at present, to minimize errors due to the absorption of impurities. We prefer a purity of about 75 per cent, *E*(1 per cent, 1 cm.) (370 mμ) = about 1,000, but procedures for concentrating preparations of lower purity are under study.

The equation employed in the Distillation Products Industries Laboratory is:

$$\text{Percentage } iso\text{-}a + iso\text{-}b \text{ in mixed isomers} = \frac{100\ k_a - (k_b + 0.01)}{k_c \times P}$$

where k_a = the extinction coefficient for the test sample at 8.73μ (1 per cent solution in carbon disulphide, 1 mm. cell, Perkin Elmer, Model 21, instrument, sodium chloride prism, slit programming No. = 9.75); k_b = the extinction coefficient at 8.48μ for the test sample; this value plus 0.01 is the 'background' correction determined with pure all-*trans* and neovitamin A aldehydes in a ratio (3 : 1) which approximates that present in the mixed isomer preparations studied; k_c = the extinction coefficient at 8.73μ for pure *iso-a* and *iso-b* retinenes in a ratio (3 : 1) which is approximately that present in the mixed isomer preparations studied; P = the concentration (per cent) of the total retinenes determined by the antimony trichloride reaction.

This work between the two laboratories was initiated and co-ordinated by Dr. J. G. Baxter, Distillation Products Industries, with the co-operation of Prof. G. Wald, Harvard University. Related bioassays and analytical studies by members of the Biochemistry, Vitamin Development and Organic Research Laboratories, Distillation Products Industries, were helpful in guiding the direction taken in the work. These bioassays and analyses will be reported separately.

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LIVER GLUCOSYL OLIGOSACCHARIDES AND GLYCOGEN; CARBON-14 DIOXIDE EXPERIMENTS WITH HYDROCORTISONE

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IT has not been possible for geographical reasons to continue a collaborative study designed to clarify, through the use of carbon-14 dioxide, the biochemical significance of liver glucosyl oligosaccharides, particularly in relation to the action of adrenal corticoid hormones. We therefore wish to report our findings to date.

Sie and Fishman[1] observed earlier that hepatic glucosyl oligosaccharides fluctuated in the same direction as did liver glycogen in starvation, glucose feeding and insulin administration. Under these conditions, our concern lay with the dynamics of the glucose unit, either produced from glycogen, as in starvation or in insulin administration, or exogenously provided in the glucose feeding experiment. On the other hand, liver glycogen resulting from the action of hydrocortisone in fasted rats[2] is considered to originate from the catabolism of protein. Since hexose synthesis from pyruvate and lactate is believed to require carbon dioxide fixation[3], hepatic gluconeogenesis could be followed with carbon-14 dioxide without supplying an exogenous substrate or preformed glucose units. The following experiments have been carried out.

In the first series of experiments, male Wistar rats (150–175 gm.), after 22–24 hr. of fasting, were injected with 50 μc. of carbon-14 dioxide bicarbonate (isotonic saline, intraperitoneally) 1 hr. before killing, and at 3 hr. and 5 hr. after hydrocortisone (5 mgm./animal in saline microcrystalline suspension) was injected by the same route (Fig. 1). In the second series of experiments, 50 μc. of radioactive bicarbonate was injected 3 hr. after an initial injection of 5 mgm. of hydrocortisone. Animals were killed afterwards at intervals up to 3 hr. (Fig. 2).

At the times indicated, the experimental animals were killed by decapitation, and the livers rapidly removed and frozen in a dry ice bath. A 10 per cent homogenate of each liver was prepared with ice-cold water, keeping the homogenizer packed in ice. This mixture was deproteinized by additions of 10 ml. of 5 per cent zinc sulphate and 10 ml. of 0·3 N sodium hydroxide solution. After centrifugation, the precipitate was washed twice with 10 ml. of cold distilled water, and the washings and supernatant solution were pooled. The oligosaccharides were adsorbed from this mixture with charcoal, which was then washed with copious amounts of distilled water, and eluted afterwards with hot ethanol[1]. Total glycogen was isolated by Roe's method[4]. Glycogen and oligosaccharides were hydrolysed with hot mineral acid[5], and the glucose was estimated by the Nelson method[6]. Tail vein blood was obtained for the determination of carbon dioxide and glucose[7]. The quantity of carbon dioxide in the blood was determined in the Van Slyke apparatus and was recovered and counted as barium carbonate. Glucose was isolated as phenylosazone[8], which was recrystallized, plated and counted. A Robinson flow counter was used for the radioisotope assays[9].

The following observations are made. Animals whose liver glycogen had been almost completely depleted by fasting not only possessed a significant amount of glucosyl oligosaccharides, but also they exhibited about four times the specific radioactivity found in the glycogen and contained virtually all the labelled hexose. With the stimulation of gluconeogenesis by compound F, the specific activity of the glucosyl oligosaccharides diminished, while that of glycogen increased at the 4 hr. interval. In Fig. 2, where it is possible to follow all the events as a function of time after compound F and carbon-14 dioxide administration at the times indicated, it required about 1 hr. for the carbohydrates to incorporate the maximum level of carbon-14. In the early part of this process (between 3·25–3·5 hr. after compound F) the glucosyl oligosaccharides became more richly labelled than

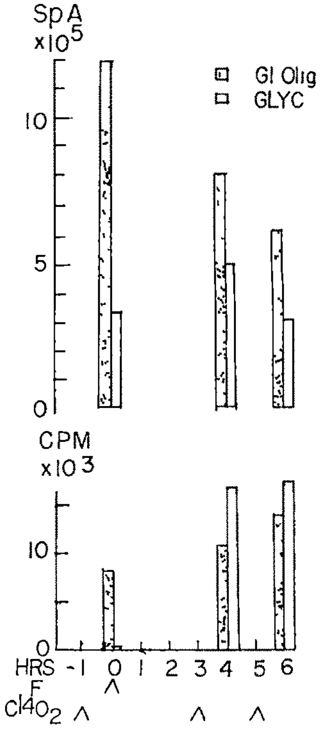

Fig. 1. Carbon-14 labelling of liver glucosyl oligosaccharides and glycogen in relation to the administration of compound F. Note that the animals were killed in each instance 1 hr. after the injection of carbon-14 dioxide. The numbers of rats employed for each time interval were, respectively: –1 to 0, 2; 0 to 4, 4; 0 to 6, 2

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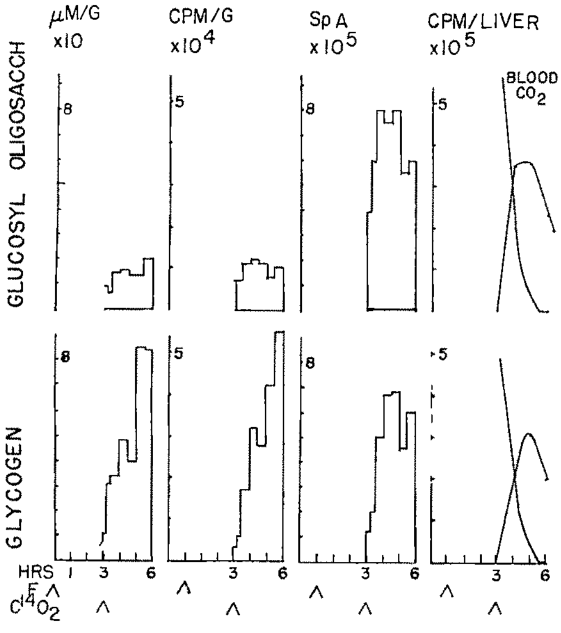

Fig 2 Carbon-14 turnover in liver glucosyl oligosaccharides, glycogen and blood carbon dioxide in relation to compound *F* administration The number of animals used was two at each time interval except for the 4-hr column (4 rats) The relative specific activity of blood carbon dioxide was computed on the assumption that carbon-14 dioxide was incorporated into only carbons 3 and 4 of glucose The observed c p m /mole of barium carbonate have been divided by three, and the same plot (descending curve) appears for both glucosyl oligosaccharides and glycogen

the glycogen by a factor of 3 and for another 2 hr still remained more radioactive per milligram of polysaccharide glucose This situation is reflected in the curves relating total counts per liver of each carbohydrate category against a background of rapid carbon-14 dioxide disappearance from the blood After 3 5 hr the glucosyl oligosaccharides exhibited a constant number of counts per gm of liver, whereas those for glycogen continued to rise to the end of the period investigated (6 hr) However, for this interval, specific activity of glycogen paralleled that for the glucosyl oligosaccharides In general, carbon dioxide fixation matched carbohydrate synthesis following the injection of hydrocortisone

The interpretation which appears best to fit the above facts is the following Pyruvate and lactate (since these fix carbon dioxide during their conversion to glycogen) are probably the major protein-supplied precursors of glucosyl radicals in fasted rats treated with hydrocortisone These glucosyl radicals are first linked into individual members of a homologous family of glucosyl oligosaccharides (maltose, maltotriose, maltotetraose, etc) which is 'turning over' rapidly Under the proper physiological stimulus (glucose feeding, compound *F*) these oligosaccharides are assembled into macro-molecules of glycogen

In our previous work, first consideration was given to isolating, identifying, characterizing and determining quantitatively liver glucosyl oligosaccharides[10], and the next concern was to rule out the possibility of artefact due to the operation of extraneous factors of either a biochemical or physical nature[1,10] Our attention was directed recently to the question of the origin of glucosyl oligosaccharides and their possible significance in the metabolism of liver glycogen The implication of previous experiments[1] (starvation, glucose feeding, insulin administration) and the work of others[11] with rat diaphragm was that glucosyl oligosaccharides (no matter what their origin) may enter somewhere into the mechanism of glycogen synthesis The present results supply direct evidence in support of this suggestion

This work was supported in part by grants-in-aid (*P*-106) from the American Cancer Society, Inc., New York, (860-*C*2) from the Massachusetts Division of the American Cancer Society, Boston, Mass , and (*C*-3213) from the National Cancer Institute, National Institutes of Health, Bethesda, Md

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RELEASE OF NUCLEOTIDES FROM YEAST CELLS

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IT is well known that when *Lactobacilli* are cultured in association with yeast, the former organisms are able to proliferate in a simple medium containing no growth factors specific for them The resulting growth of *Lactobacilli* is mainly dependent on vitamins, purine and pyrimidine bases secreted by the yeast cells into the medium[1,2] The present communication contains a description of the ultra-violet-absorbing materials released from the yeast cells and the conditions influencing their release

Beer yeast (*Saccharomyces cerevisiae*, Yebis) subcultured for 72 hr at 30° C in a synthetic medium was incubated for 5 hr at 30° C in the same medium containing phosphate-^{32}P After harvesting and washing three times with distilled water, the labelled cells (dry weight, 1,760 mgm) were suspended in 400 ml of 0 08 *M* sodium citrate buffer (*p*H 6 0) with 2 per cent glucose added, and incubated for 3 hr at 30° C The supernatants after incubation had an ultra-violet absorption spectrum with a maximum at 258 mμ and a minimum at 235 or 240 mμ

The ultra-violet-absorbing materials released from the cells were almost completely adsorbed by a charcoal column pretreated with 8 per cent *iso*octanol

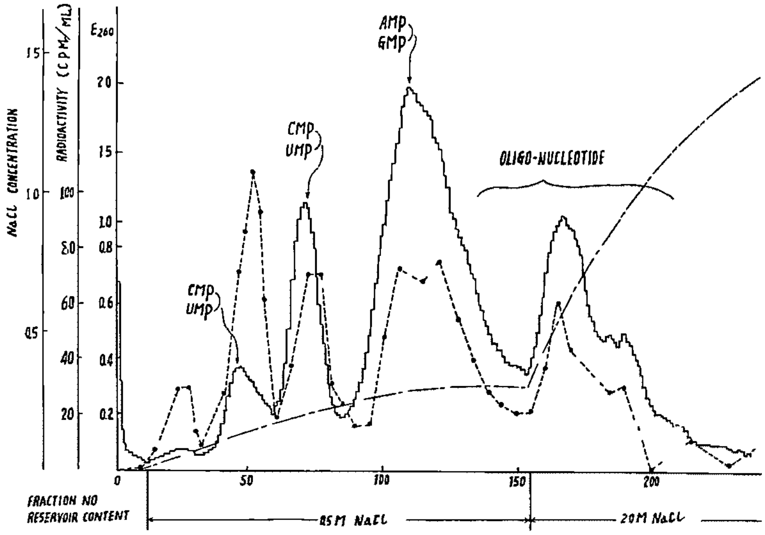

Fig 1 Separation of the nucleotides released from yeast cells labelled with phosphorus-32 during their incubation in citrate buffer Column, 'Dowex-2' (chloride), 200–400 mesh, 12 cm × 0 785 cm², elution, the initial mixer content was 500 ml water, and the reservoir content was 500 ml of 0 5 *M* sodium chloride, then 500 ml of 2 0 *M* sodium chloride solution Each effluent was collected in 4 7 ml portions with a fraction collector Sorbed materials, the ultra-violet-absorbing materials prepared as described in text ———, Optical density at 260 mμ, – – – –, radioactivity (c p m /ml), —·—·—, sodium chloride concentration in the effluents CMP, Cytidine monophosphate, UMP, uridine monophosphate, AMP, adenosine monophosphate, GMP, guanosine monophosphate

More than 80 per cent of the adsorbed material was eluted with 0 3 per cent ammonia–50 per cent ethanol solution The eluate from the charcoal was neutralized with 'Dowex 50' (acid type) resin, and then passed through 'Dowex 2' (chloride type) resin The adsorption in this step was more than 90 per cent The column was washed with water, and the adsorbed material was separated with a sodium chloride solution by the gradient elution technique[3] The optical density at 260 mμ and 280 mμ and the radioactivity of each effluent were measured

The results for six fractions are shown in Fig 1 The positions, but not the heights, of optical density peaks agree well with those of radioactivity The initial fractions (eluted with less than 0 3 *M* sodium chloride solutions) were rechromatographed on 'Dowex 1' (formate type) and then on paper, the monophosphates of cytidine, uridine, adenosine and guanosine were identified in this way The oligonucleotide fractions (eluted with 0 3–1 5 *M* sodium chloride) followed the mononucleotides The recovery using sodium chloride solution, even up to 4 0 *M*, was only about 60 per cent of the calculated amount of adsorbed material However, when a mixture of 4 0 *M* sodium chloride and 1 0 *M* sodium hydroxide solutions was used as eluant, the residual material was almost completely separated from the column This alkali-eluted fraction, the final eluate, contained four mononucleotides, which would presumably be derived from polynucleotides hydrolysed by alkali during the elution Details of this chromatogram will be published elsewhere

Oligo- and poly-nucleotides formed more than 60 per cent of the total nucleotides released, and the ratio of purine bases to pyrimidine ones in the mononucleotide fractions was 2 5, though it was 1 2 overall These ratios depended on the experimental conditions Most of the nucleotides released were probably fragments of the cellular ribonucleic acid, since scarcely any 5′-nucleotides were in any fraction, and amounts of the nucleotides released corresponded approximately to the decrease of cellular ribonucleic acid Moreover, the quantity of nucleotide released was greater than that in the pool (fraction soluble in cold acid) which decreased during incubation

As shown in Table 1, distilled water, sodium chloride and potassium chloride solutions and a synthetic growth medium did not cause a release of nucleotides when used as the incubation medium, acetate or succinate buffers had a slight effect and phosphate or citrate buffers rather more effect This stimulation of citrate or phosphate might be well attributed to their chelating action, since ethylene-diamine tetraacetic acid, a notable chelating agent, markedly accelerated the nucleotide release, and the addition of *M*/100 magnesium sulphate to *M*/50 citrate buffer resulted in a 50 per cent reduction of the release

Inhibition of the release in citrate buffer was not observable in the presence of either ordinary antibiotics (penicillin, 20 μgm /ml, streptomycin, 300 μgm /ml, and chloramphenicol, 20 μgm /ml) or of metabolic inhibitors (sodium azide, 10^{-3} *M*, Na_2HAsO_4, 2×10^{-2}, and 2,4-dinitrophenol, 5×10^{-4} *M*), except monoiodo-acetic acid which produced a slight drop at 10^{-3} *M* The *p*H optimum for the release in citrate or phosphate buffer was 6 0–7 0 and an acid *p*H suppressed the release Several treatments which disrupt the permeability barrier of yeast cells, for example, freezing and thawing, treatment with organic solvents, and short-time sonication of the cells, stimulated the release considerably After such treatment an enhancing effect of citrate was also discernible However, it is possible that the materials released in these conditions are not the same as the nucleotides released by the intact cells, since the supernatant of the citrate buffer incubated with sonicated or frozen and thawed cells showed an increased absorption at 230–250 mμ, which disappeared on acidification with perchloric acid

Recently, a similar phenomenon has been reported by Holden[4] for *Lactobacilli* His results, and ours[13],

Table 1 EFFECT OF INCUBATION MEDIUM ON THE RELEASE OF NUCLEOTIDES FROM THE YEAST CELLS

All results are expressed in terms of 100 mgm (dry weight) of the cells

Incubation medium	Released nucleotide-phosphorus (μgm)
Distilled water	46 5
0 08 *M* sodium chloride solution	33 0
0 08 *M* potassium chloride solution	34 5
0 08 *M* sodium acetate buffer (*p*H 5 0)	65 0
0 08 *M* sodium succinate buffer (*p*H 5 0)	62 0
0 08 *M* sodium phosphate buffer (*p*H 5 0)	80 5
0 08 *M* sodium citrate buffer (*p*H 5 0)	115 0
M/100 Ethylenediamine tetraacetate (*p*H 4 2) solution	68 0
M/100 Ethylenediamine tetraacetate (*p*H 5 0) solution	102 0
Synthetic growth medium	45 0

Beer yeast cultured in a synthetic medium for 72 hr at 30° C was incubated in 10 ml of medium containing 2 per cent glucose for 3 hr at 30° C The released nucleotide-phosphorus was determined as follows The extinctions in the supernatant of the incubated media were measured at 240, 260 (E_{260}) and 280 mμ respectively, with a Beckman *DU* spectrophotometer, and the E_{260} due to the released nucleotides was obtained by subtracting the blank (the medium free from cells) from the E_{260} of the supernatant Thus, the nucleotide-phosphorus could be calculated according to Ogur and Rosen (ref 12) strongly suggest that citrate has a chelating effect which affects the release of nucleotides from the microbial cells.

On the basis of these results, it might be suggested that the presence of citrate or other chelating substances in a medium may remove calcium or magnesium ions from the cell surface, leading to destruction of ribonucleic acid and present in it, and thus to a release of nucleotide fragments. Several facts support this. For example, pancreatic ribonuclease is inhibited by the addition of magnesium or calcium ions[5], and a ribonucleic acid-rich fraction obtained from the cells of *E. coli* contains more magnesium than other fractions[6]. Further, ribonucleoprotein has apparent[7,8] or latent[9] ribonuclease activity.

On the other hand, it has often been observed that the degradation of ribonucleic acid and the release of ribonucleate from yeast cells takes place by autolysis[10,11]. The release of nucleotides under our experimental conditions may also be connected with cell autolysis. However, it seems reasonable to distinguish between the two, since the release in our case did not result in the death of the cells or even in degradation of the cell protein. In contrast, a considerable release of amino-acids occurred only when the yeast cells were incubated in the acetate buffer, which accelerated release of nucleotide only slightly.

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NEW ANTIMETABOLITES OF VITAMIN B_{12}

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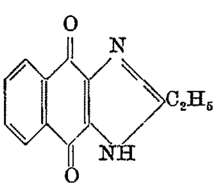
OUR interest in the role of vitamin B_{12} in cancer was first stimulated by the claims of Bodian[1], that prolonged regression of neuroblastoma in infancy was effected by massive dosage of the vitamin. It was therefore thought that the therapeutic effect claimed might be related to an imbalance in B_{12} metabolism caused by excess of the vitamin, and that such an effect might possibly be better produced by the administration of a B_{12} antimetabolite[2].

Hitherto, the only known B_{12} antimetabolites have been those described by Lester Smith[3], which were derived from the structure of B_{12} by very minor modifications, and also those which are relatively simple derivatives of the benzimidazole molecule[4,5]. The relation between tumour inhibition and anti-B_{12} action is shown in a member of the latter group by the effect of 2-ethyl-2,3-naphthimidazole-4,9-dione (I), which induced partial regression of a mouse mammary adenocarcinoma[6] and was also a competitive antagonist of vitamin B_{12} in an *E. coli* mutant[4].



(I)

We have explored a fairly wide variety of chemical types, chosen for their possible relation to B_{12} metabolism, for an antimetabolite action in a microbiological system. Our particular test organism was *E. gracilis* var. *z*—a highly sensitive B_{12}-dependent flagellated green alga. The basal growth medium and techniques of incubation were based on those described by Hutner *et al.*[7]

A series of approximately a hundred compounds was screened for inhibitory activity at 500 μgm./ml. levels, at low concentrations of vitamin B_{12}. Compounds producing more than 50 per cent inhibition of growth, as assessed in a colorimeter (measuring both turbidity and colour), were afterwards re-tested in definitive assays. An orthogonally designed test system was used, with varying concentrations of antagonist up to 500 μgm./ml. in the presence of 0, 10, 100 and 1,000 μμgm. B_{12}/ml. The growth response in these tests was measured by a pigment extraction technique using an acetone–ethyl acetate solvent system due to Epstein and Weiss[8].

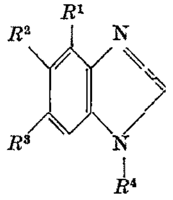
Results are expressed in terms of concentration of antagonist required to produce 50 per cent inhibition of growth at 10,100 and 1,000 μμgm. B_{12}/ml. respectively. The values given are only approximate. As can be seen from Table 1, seven out of the fifteen compounds so far found active on screening produced a competitive B_{12} antagonism.

We think that the discovery of an antimetabolite action in the pteridine and nicotinamide structures is interesting because, unlike the benzimidazoles or purines, they are not analogous in structure to any moiety of the B_{12} molecule. These observations indicate that there may be a variety of enzymes or co-factors closely concerned with the utilization of B_{12}, and that each one may be structurally specific for a particular inhibitor. Thus, the pteridines might compete with a pteridine type co-factor or metabolite for a particular enzyme, and the nicotinamide derivatives might interfere with some function of diphosphopyridine nucleotide (cf. Timmis[9]).

Table 1 CONCENTRATIONS OF ANTAGONISTS (μGM /ML) PRODUCING 50 PER CENT INHIBITION OF GROWTH OF *E gracilis*
Results in the case of compounds producing competitive antagonism are given in italics

Structures of compounds tested, (*a*), (*b*) , are on the right

Structural type	Formula	Concentration antagonist (μgm / ml) required to produce 50 per cent inhibition of growth		
		B_{12} (μμgm /ml) 10	100	1,000
(*a*) Benz-imidazoles	4-nitro-6-chlorobenzimidazole ($R^1 = NO_2$, $R^2 = H$, $R^3 = Cl$, $R^4 = H$)	110	88	78
	5,6-dichlorobenzimidazole ($R^1 = R^4 = H$, $R^2 = R^3 = Cl$)	106	90	94
	4,5,6-trichlorobenzimidazole ($R^1 = R^2 = R^3 = Cl$, $R^4 = H$)	70	65	63
	4,5,6-trichlorobenzimidazole riboside ($R^1 = R^2 = R^3 = Cl$, R^4 = ribosyl)	*70*	*160*	*230*
(*b*) Diaza-benz-imidazole	5-bromo-2,7-diazabenz-imidazole	190	178	173
(*c*) Purines and aza-purines	Purine ($R^1 = R^2 = H$, $X = CH$)	138	173	138
	Purine riboside ($R^1 = H$, R^2 = ribosyl, $X = CH$)	58	62	60
	6-mercaptopurine ($R^1 = SH$, $R^2 = H$, $X = CH$)	*200*	*>500*	*>500*
	9-furfuryl-8-aza adenine ($R^1 = NH_2$, R^2 = furfuryl, $X = N$)	*450*	*>500*	*>500*
	2-diethylamino-6-*p*-dimethyl-aminophenylethyl purine ($R^1 = (CH_2)_2C_6H_4N(CH_3)_2(p)$)	*150*	*>500*	*>500*
(*d*) Pyrimidine	5-fluorouracil	78	55	54
(*e*) Pteridines	4-mercaptopteridine ($R^1 = SH$, $R^2 = H$)	*95*	*350*	*333*
	2-amino-4-*p*-diethylamino-styrylpteridine ($R^1 = (CH)_2\,C_6H_4\,N(C_2H_5)_2\,(p)$, $R^2 = NH_2$)	*73*	*>500*	*>500*
	4-dimethylaminopteridine ($R^1 = N(CH_3)_2$, $R^2 = H$)	*400*	*>500*	*>500*
(*f*) Nicotin-amide de-rivative	N-2-chloroethyl-β-naphthyl-aminoethyl-3-carbamoyl-pyridinium chloride	*200*	*430*	*415*



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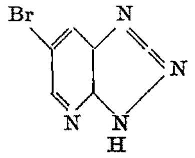

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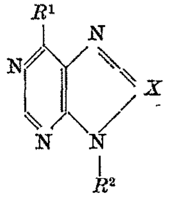

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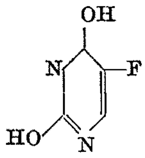

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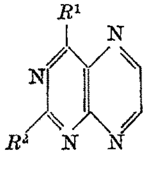

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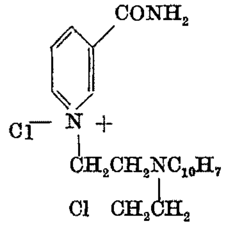

(*f*)

There are interesting differences between the results obtained in our microbiological system and in the *E coli* mutant used by McNair Scott *et al* [5], for example, 6-chloro-4 nitrobenzimidazole was not a competitive antagonist in our hands, in contrast to 4,5,6-trichlorobenzimidazole riboside On the other hand, McNair Scott *et al* [5] found these compounds to be competitive and non-competitive antagonists respectively

It is generally held that 6-mercaptopurine, one of the most effective drugs for the treatment of acute leukæmia, inhibits growth by interfering with nucleic acid and protein synthesis. Its action in this disease, however, has not with any certainty been related to an antipurine effect Since we have found that this drug is a competitive B_{12} antagonist (Table 1), we would like to direct attention to the possibility that anti-B_{12} effect might be involved in the action of 6-mercaptopurine This speculative suggestion could be supported by the view of Osgood[10] that the bone marrow in untreated pernicious anæmia shows several features in common with that in acute leukæmia If the two diseases are accordingly related, acute leukæmia may, like pernicious anæmia, be dependent on some derangement of B_{12} metabolism, each in its own way

Forrest *et al* [11] have very recently isolated a simple pteridine from the bodies of blue-green algae It is shown above that a number of pteridines of comparable simplicity are vitamin B_{12} antimetabolites in the B_{12}-dependent system *Euglena gracilis* On reading our manuscript, Dr G E Fogg suggested that the apparent inability of blue-green algae and Euglenidae to co-exist in Nature, a hitherto unexplained phenomenon, may be due to an antagonism between the blue-green algae pteridine and the vitamin B_{12} of B_{12}-requiring *Euglena* We are now investigating this hypothesis

A full report of this work will shortly be submitted to the *British Journal of Pharmacology and Chemotherapy*

The investigation has been supported by grants from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund and the National Cancer Institute of the National Institutes of Health, U S Public Health Service

We thank Dr G B Brown and Dr K Folkers for gifts of purine riboside and 4,5,6-trichlorobenzimidazole riboside respectively

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LOW-TEMPERATURE AUTORADIOGRAPHY FOR THE DETECTION OF TRITIUM IN TISSUE, WITH REMOVAL OF LUMINESCENCE INDUCED BY TRITIUM

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NUMEROUS studies have shown inequalities in the distribution of labelled water in the different organs and various compartments containing liquid in the normal animal[1,2] during the pre-equilibrium period

It seemed of interest to investigate by means of photographic recordings the kinetics of this distribution, working on animals (young rats) killed at fixed intervals of time For that purpose we used the low-temperature autoradiographic technique[3,4], the only method which, because of the rapid freezing of the animal, eliminates post-mortem diffusion of the water while at the same time guaranteeing the absence of known pseudo-radiographic effects

We wished first to obtain an image of homogeneous diffusion in the whole of the organism, under conditions close to equilibrium, and this formed the object of the present work

The photographic recordings obtained by this technique, applied to young rats after administration of 20 mc of tritiated water, gave unexpected results (Fig 1*a*) They show no blackening corresponding to lungs, liver, spleen, muscle On the other hand, a slight darkening shows up in the region of the intestinal walls and the subcutaneous tissue, and a very intense blackening at the sites of the eye, the brain, the preformed teeth, the stomach, the bladder and the intervertebral disks

Since these results disagreed with the known distribution of water in mammals, we removed organs from young rats treated in the same way except that the dose injected was between 0 4 and 1 5 mc of tritiated water (HTO) in a volume of 0 1–0 2 ml of saline The radioactivity of the water obtained by distillation of the organs was measured by liquid scintillation[5,6]

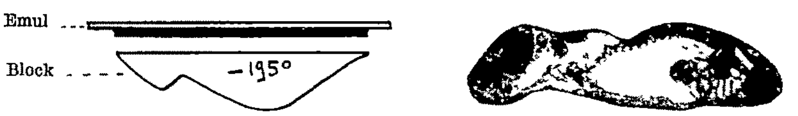
It is shown in Table 1 that the specific radioactivity of the water (mμc /mgm) is of the same order for the blood and for organs such as the brain, the liver and spleen, the kidneys and the intestines On the other hand, the milk in the stomach has not yet reached the isotopic concentration of HTO in the other organs The specific radioactivity of the water in the total eye, the crystalline lens and the ocular residue after elimination of the crystalline lens is more or less identical with that of the blood We have also noted that for the eye the radioactivity was entirely due to the water, and that no measurable tritium was incorporated in the dry residue

Table 1 SPECIFIC RADIOACTIVITY OF WATER IN THE ORGANS OF YOUNG RATS WEIGHING 14–20 GM , AGED 6–14 DAYS, 10 MIN AFTER SUBCUTANEOUS OR INTRAPERITONEAL INJECTION OF 0 1–0 2 ML OF SALINE CONTAINING 0 4–1 5 MC TRITIATED WATER, STANDARD DEVIATION ± 2 PER CENT

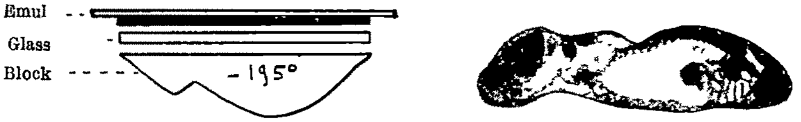
Organ	Millimicrocuries of HTO per mgm water				
	Rat 21	Rat 23	Rat 15	Rat 19	Rat 20
Blood	—	44	88	80	80
Brain	44	43	90	92	75
Liver, spleen	45	—	—	88	90
Liver, spleen, kidneys	—	46	85	—	—
Bowel, small and large, with contents	48	45	80	92	91
Stomach containing milk	—	—	41	37	46
1 eye*	40	36	—	88	—
1 crystalline lens*	46	—	—	85	40
1 eye without crystalline lens*	42	—	—	90	—

* The water content is calculated on the basis of 70 per cent of water for the crystalline lens and 80 per cent for the rest of the eyeball

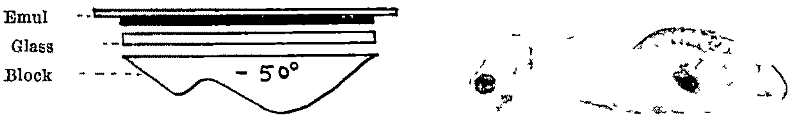
In view of the disagreements found between the photographic recordings and direct measurements, we have looked into the mechanism of autoradiography itself in an attempt to find the cause of these paradoxical images , this has led to the discovery of a phenomenon of luminescence produced at low temperature under the influence of the very soft tritium beta-rays, actually within certain tissues of the organisms studied



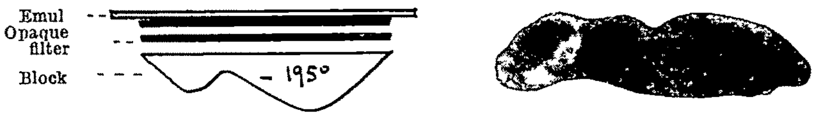
(*a*) 20 min at −195° C No filter



(*b*) 20 min at −195° C With glass filter



(*c*) 20 min at −50° C With glass filter



(*d*) 21 days at −195° C With opaque screen

Fig 1 Two-day-old rat Subcutaneous dorsal injection of 20 mc deuterium oxide 20 min after injection

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This is demonstrated by the following series of experiments (Fig 1) carried out on rats 48-hr old, killed 20 min after dorsal-subcutaneous injection of 20 mc of tritiated water

(1) (See Fig 1*a*) The machined block at −195° C is applied directly against the emulsion The exposure lasts 20 min at liquid-nitrogen temperature In this way the paradoxical image described above is obtained

(2) (See Fig 1*b*) Exposure of the same block at the same temperature for an equal period, but with a 1-mm thick sheet of glass interposed, gives an image identical with the preceding one Since, however, the maximum energy of tritium beta-particles (18 keV) is not great enough to allow their passage through this thickness of glass, the image obtained is not due to a direct action of tritium radiation on the emulsion and can only result from a luminescence

(3) (See Fig 1*c*) On repeating experiment *b* at a temperature of −50° C., a general decrease in blackening is noted, although the distribution is not altered

(4) (Fig 1*d*) Finally, exposure for 21 days at −195° C with a screen of opaque carbon paper interposed between the block and the emulsion gives a true autoradiographic recording on which quite a homogeneous distribution of blackening is observed

From this limited study, some characteristics of this luminescence produced by the local absorption of tritium beta-radiation by certain tissues can be formulated It becomes more intense as the temperature is lowered For a uniform distribution of tritiated water in the organism, the intensity of this fluorescence varies greatly according to the nature of the tissue

For the exposure time used, the threshold of blackening detectable on the emulsion for tritium beta-radiation is not reached at any point of the recording, while the phenomenon of luminescence reaches saturation in the region of the eye, as shown in Fig 1*a* When a screen opaque to light is interposed (Fig 1*d*) the exposure time to obtain an appreciable blackening is 1,600 times longer than in the case of exposure without screen (Fig 1*a*) It may seem surprising that part of the tritium beta-radiation (mean path in water, 1μ) can pass through a thickness of paper of the order of 50μ We believe that the explanation may be found in the fibrous structure of the paper

We may assume that the autoradiographic recordings obtained under the conditions of experiment *d* (with opaque screen) represent exactly the distribution of tritium at the surface of the machined block

After dorsal subcutaneous injection of tritiated water, the autoradiographs show instantly homogeneous diffusion of the activity, the only exceptions being the bones, the teeth and the milk contained in the stomach The teeth and the milk, however, form exceptionally luminescent zones The region of dorsal injection naturally corresponds to a more intense blackening

The detailed mechanism of this luminescence is difficult to interpret and belongs to the field of structural physics We do not, in fact, know the chemical nature of the luminescent substances present in the frozen organs, still less their molecular structure at −195° C, or their behaviour in the presence of beta-radiation

Validity of low-temperature autoradiography The above statements could lead to some doubt concerning the value of recordings obtained by low-temperature autoradiography with radioelements other than tritium[3,4] We have verified that this is not the case, in particular with sulphur-35 and calcium-45 Fig 2*a* shows the result of autoradiography without screen carried out on a young rat, 90 min after dorsal subcutaneous injection of 30 μc of calcium-45 chloride, with a 17-hr exposure In Fig 2*b* the interposition of a glass screen eliminates all recording for this exposure period (except for the left fore part of the head which was not covered by the glass sheet), the luminescence effect, therefore, does not appear under these conditions for calcium-45 radiation

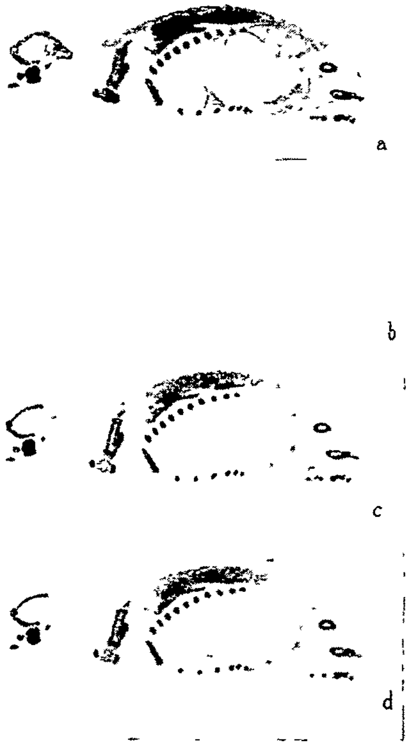

Fig 2

The recording in Fig 2*c* and *d*, carried out after interposition of a carbon paper screen and of an aluminium screen 0 2 mm thick, respectively, can be strictly superimposed on the direct autoradiograph *a*, with the difference only of general blackening, which is slightly decreased by the screens used for *c* and *d*

In tests carried out under the same conditions of metabolism and exposure after injection of 50 μc of sulphur-35, by direct contact and with interposition of a carbon paper screen, an absence of luminescence was again observed

We conclude that the luminescence effect of tissues at very low temperature is only detectable for extremely soft radiations such as that of tritium. It is advisable, however, in applying autoradiography at very low temperature to other radio elements, to verify that the interposition of an opaque filter does not modify the images obtained by direct contact between the block and the emulsion

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A ZOOLOGICAL SURVEY OF MADAGASCAR

By Dr. RENAUD PAULIAN

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THE survey of tropical faunas has, for nearly two centuries, been largely limited to the haphazard methods of the general collector or to the painstaking but limited efforts of individual specialists. The results, as could be predicted, were of very doubtful value when either ecological or biogeographical projects were considered. However, they were extraordinarily successful in so far as they brought to light a very large number of new forms and built up our present knowledge of taxonomy. It unfortunately proved impossible to compare, with any accuracy, the faunas of two neighbouring areas for any scientific purpose. This did not prevent ambitious workers from building biogeographical or ecological systems on a very large scale. Yet to the man working in the field these systems seemed always rather unsafe, even though they called in all the resources of the geological and statistical methods and very strict logical constructions.

As a tropical country, Madagascar had for some time the very rare distinction that a series of monographs in the *Histoire Physique, naturelle et politique de Madagascar* had been published by the combined efforts of A. and G. Grandidier. It could thus compare with Central America, Seychelles, Hawaii or British India. But even these monographs, mainly published during the second half of last century, are now considered out of date.

In the years following the Second World War, research work on tropical faunas has started on completely revolutionary lines. New research institutions and groups are either working permanently in tropical areas or covering these in terms of long-range work. They are thus enabled to collect intensively the whole year round, using breeding methods and many new collecting systems. Such teams are at work in the Belgian Congo, Micronesia, Melanesia, etc.

The Zoological Survey started in Madagascar in 1947 and is still at work. It would seem from published results[1] that it has been particularly successful. It is centred on the Zoology Department of the Institut Scientifique de Madagascar, an institution covering pure and applied research in most fields of human, animal and plant biology and in soil science, hydrology and geography. The Institute itself belongs to a chain of tropical institutes created after 1946 by the French Office de la Recherche Scientifique et Technique Outre-Mer in what was then the French Union and is now the French Community.

It may be of interest, considering the variety of results obtained in the short period 1947–59, to give some details on the practical organization of the Survey before describing the changes wrought in our knowledge of the local fauna.

Considering that only limited means could be brought to bear on the problem of such a survey, the following principles have been applied:

(*a*) The formation of a mobile team with one or two European scientists, a number (3–6) of native assistants, a 'Landrover', and all the basic collecting equipment. This team has the use of a small permanent workshop in the centre at Tananarive for the building of new gadgets, and the constant upkeep of the material used.

(*b*) A central office, with one to three European scientists and three or four native assistants, which receives the collections, prints the labels, mounts and sorts the material and makes a preliminary study of all collections. More breeding work is carried on in the insectarium of the Central Office.

(*c*) A very large team of honorary research workers, specialists of international reputation, from practically every country of the world. They have agreed to work out collections made in Madagascar from their special groups. They are responsible for describing any new or remarkable forms and preparing revisions of such families, tribes or genera which may be considered as fairly well known. More than a hundred specialists have been enlisted in this way.

(*d*) A practical organization enlisting the co-operation of well-known foreign specialists, giving them all possible help and practical local guidance, helping them with the necessary camping and collecting outfit, etc. This organization can help specialists who come to Madagascar on their own, arrange for joint expeditions, or even finance complete expeditions, to which they are invited. In this way, during the past ten years, no less than thirty-three zoologists have taken part in the survey and some of them have spent more than a year in Madagascar or have come several times. The 'geographical distribution' of these specialists is worth noting: two Mauritians, five South Africans, one Rhodesian, two East Africans, three Swiss, three Austrians, three Italians, one German, eight Americans, one Australian and five French. In all cases the material collected or the observations made are embodied in the general publications of the Institute.

(*e*) Means for regular and so far as possible prompt publication of results. These have been obtained by the channel of two new scientific periodicals: papers on the local fauna make up the whole of the *Mémoires de l'Institut Scientifique de Madagascar*, Series A (zoology) and E (entomology), and are the main topic in the *Naturaliste malgache*. Whenever a group seemed sufficiently well known, a revision is published in the series "Faune de Madagascar", on the plan of the well-known "Faune de France". Apart from the nine published volumes of this series, three other volumes are ready to be printed and half a dozen others (covering such groups as birds, Acridoidea, Vespidae, Tingidae) are being actively prepared.

It was planned at the start to limit the survey to Madagascar proper. However, it was soon found necessary to cover the insular environment, the Mascarenes, the Comoros and the small atolls or coral reefs (Tromelin, Europa, Glorioso). Although the knowledge we may gain of their fauna is completely independent of Madagascar proper, it is a great help towards an understanding of the malagasy fauna itself.

It is still too early to give a complete analysis of the results of the Survey. More than a million specimens have been collected, covering the whole animal kingdom from protozoa to mammals, and a very large part of this material is still undergoing systematic study.

From the purely taxonomical side more than 2 500 new forms (subfamilies, tribes, genera and species) have been described. Many orders have been discovered on Madagascar proper (for example, fresh-water Coelenterata, Porifera, Bryozoa, in Insecta Zoraptera, Plecoptera, Diploura, Protoura, in Chelicerata Palpigrada, Uropyga, Amblypyga, in Crustacea Syncarida) and many more groups. No animal group has remained untouched, and often the known number of forms has risen by as much as 500 per cent.

The very great variety of new forms found in the island has completely changed its aspect and helped to build an entirely new system of biogeographical relations.

The Survey has opened up a number of new biota: many new groups of cave-dwelling forms have been detected, such as scorpions and Homoptera, that were not known previously from this habitat, a very large and highly specialized blind soil-fauna, probably one of the richest in the world, a series of crustaceans and worms inhabiting interstitial waters, both salt and fresh, an original intertidal fauna of land arthropods, a rich fauna living in the water found in leaf axils of palms, Musaceae, Aroideae and in bamboos. This last fauna is exceptionally large and its members range from frogs to insects and crustaceans, mosquitoes play a very important part, with high speciation and remarkable morphological adaptations.

Less original, but quite as important results have been obtained by the systematic breeding of parasites (chalcidoids, tachinids, etc.) and of leaf-mining and gall-making insects. These researches have brought to light new biological facts for known groups, such for example as the existence of leaf-mining drosophilids.

In the extreme north of Madagascar, where recent volcanoes with rain forest co-exist with deciduous forest on limestone, sandstone or lateritic soils, a comparative study of the fauna has been most rewarding. Not only does it give many remarkable new forms but also helps in the understanding of factors underlying speciation, which is one of the most remarkable facts in the local fauna.

Some facts have been established on a firm basis and allow for biological discussion. For example, the remarkably active speciation referred to, with a high number of sympatric species, the numerous missing elements in the fauna as compared with continental Africa or the Indian subcontinent, the place and significance of the austral element, the wide plasticity of most new imported forms, etc. A number of principles underlying the building up of the fauna on small isolated islands have also been found. All these have shown that Madagascar was one of the most remarkable natural laboratories in the world for the study of species formation, adaptation and evolution. A considerable research effort should be started along such lines in the near future.

By necessity, the work until now has been mostly taxonomical, ecology has only been considered in so far as it opened up new biota, biological research has been limited to breeding work. But with the progress of the general catalogue of Madagascar's fauna research work on biology, ecology and physiology will soon be possible. If the method used has delayed a biological approach to Madagascar, it is believed that it has ensured a sure and efficient basis for such an approach and has saved many efforts and many errors due to an insufficient basic knowledge of the local fauna. It has in this way proved time-saving. The results of this Survey have shown also how completely misleading was the previous knowledge of a tropical fauna which one considered usually as fairly well known.

Thus it is quite evident that the Zoological Survey will never be finished, just as it is not finished in Britain or in France, but it may be brought to such a stage that, for most practical purposes, it can be considered as sufficient.

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BIONOMICS OF THE BRUSH-TAILED OPOSSUM *TRICHOSURUS VULPECULA* IN NEW ZEALAND

By R. I. KEAN

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DURING the latter part of the nineteenth century five Australian marsupial species were established in New Zealand—four wallabies, *Protemnodon rufogrisea*, *P. eugenii*, *P. bicolor* and *Petrogale penicillata*, together with one opossum, *Trichosurus vulpecula*.

Of the wallabies, only the first two cause loss to agricultural production, and that is not yet great because these animals occur only in restricted areas, but the opossum, which has some claim to being considered the most successful exotic mammal, is widespread, with an ecological range extending from suburban areas, through farm lands, to all types of forest. The significance of this animal to agriculture has not been thoroughly investigated, but in timber production serious loss has been caused through induced malformation of trees, mainly *Pinus* species, and in protection forests destruction of trees has been spectacular.

Economic need led to the commencement, in 1953, of systematic research on the opossum, and, to a lesser extent, on the wallabies.

Measures for control of the opossum will have to lean heavily upon a sound understanding of bionomics, but, since ecological steps are slow and are not well understood by the public, the more efficient use of poisons has been investigated, particularly methods involving application by aircraft.

Some opossum populations in New Zealand maintain balance with little artificial control, in these a female first rears an offspring in her third year, the kitten being ready for independent existence when the mother is 2 years 7 months old. A single kitten is reared in each succeeding year until about the tenth year. The bearing female exhibits little interest in the small young, but during the first two months of her kitten's pouch-free life she shows strong maternal attachment, and is aggressive towards other opossums

Under certain conditions (probably low population pressure, firmly established territory, and abundant food) some females rear their first young during their second year instead of in the third, and also rear two young annually

The female reproductive system is basically similar to its eutherian counterpart, both in that the vagina remains closed until first required for reproduction, and in that it is seasonally occluded thereafter The divergence from the eutherian lies mainly in the extreme heterochrony of development—the retention by the adult female of an embryonic tissue, the urogenital strand[2]—and in the relative lack of structure of the caudal portion of the vagina Both these marsupial characters appear to be simplifications permitted by the extreme specialization of the embryo, namely, its small size and its faculty for active locomotion before birth Seminal ducts, the so-called lateral canals, appear to have arisen phylogenetically, as suggested by T H Huxley[3], at some late prototherian stage of organization The opening of the median vaginal canal and the closing of the lateral canals during late pregnancy, apparently in response to hormones, support Huxley's hypothesis[4]

Œstrus is marked by desquamation of semicornified cells from the urogenital sinus The cycle, measured partly by smears and partly by direct observation, has been recorded by the writer as 22 or sometimes 23 days This is less than the 24½ day average (21–30) of Lyne[1] derived from smears that were made daily

Coition occurs on the night following œstrus (if œstrus is defined as the diel period of restlessness) and the single ovum is shed spontaneously approximately 24 hr later

The period of gestation was found to vary, apparently because of disturbance to the female Two pregnancies, timed from observed copulations, were completed in 17 and 18 days , others were lengthened, possibly to as long as 40 days when smears were taken, but this technique was usually associated with infertility One female from which smears were taken at two-day intervals was killed 28 days after external signs of pregnancy became obvious Copulation had occurred (ascertained by means of smear) 7 days before death The left ovary showed a 4 5-mm corpus luteum associated with a 4 8-mm blastocyst, and the right ovary an involuted 2 6-mm. corpus luteum associated with a 3 4-mm blastocyst In this case, superfœtation appeared to have occurred in the course of a prolonged gestation

Neither post-partum œstrus nor delayed implantation, as found by Sharman[5] in the wallaby *Setonix*, and almost certainly by Bowley[6] in the primitive phalanger *Cercartetus*, occurs in *Trichosurus* Sharman found that stimulation of the pouch by a contained young inhibited development of the post-partum blastocyst, but the present work on *Trichosurus* suggests that generalized stress applied to a female in early pregnancy resembles, in its effect upon the blastocyst, the maternal response to pouch young

Sperm have been found in the urogenital smear only from the third to fifth day post-coitus This result appears to be due to aspermous seminal fluid of the final ejaculation which, within about one minute, sets to form firm white copulatory plugs that completely fill the lumina of the lateral canals The plugs are later absorbed *in situ* Muscular occlusion and epithelial proliferation again seal the caudal ends of the lateral canals during early pregnancy

Male fertility, contrary to the findings of Bolliger[7] on captive opossums, shows endogenous fluctuations which may be cyclic The incidence of sperm is lowest during summer, when probably most males are aspermous for an overlapping two-month period, but, in addition to this, some males in all age classes are aspermous in each month of the year Regression of testis and urethral bulb occur, but these are not completely synchronous with the fluctuations of the cauda epididymis and its sperm

Reproduction is highly efficient Of the 106 adult females which were caught (excluding 15 pregnant or anœstrous ones) 90 carried pouch young and single corpora lutea on the ovaries, indicating almost certainly that for 84 9 per cent of this sample the first œstrus of the season had been fertile, and that the resultant young had been successfully established In the case described by Lyne[1] the newly born young's initial fall and its subsequent failure to take the teat might have been attributable to a defective maternal behaviour pattern induced by captivity

The growth of the young resembles that of man (on an equivalent time-scale) rather than that of a typical mammal , a long period of slow growth is broken by an intense adolescent spurt, which is followed by a further slow period which continues until maturity The opossum in its adolescent growth is less adaptable than man. who can defer the spurt when subject to stress , although the opossum takes three years to reach full maturity, rapid growth can occur only during the one restricted period[8]

The demands of the small young upon its parent are negligible during the first four months of life, and the bearing female passes through the period of winter stress in better condition than the male. The young makes its main growth in the spring, but slows down during the autumn period of maximum abundance, accumulating some fat before winter

Predation upon the forest opossum in New Zealand is applied only by man Natural regulation of numbers occurs through the low productivity The birth-rate can be greatly accelerated, when conditions are favourable, by the survival of young from the usually unproductive second-year juveniles, and by a spring breeding season supplementing the normal autumn one

An ultimate safeguard to forests, which are the natural habitat of the opossum, lies in the stenophagy that is characteristic of the Phalangeridae Only a limited number of tree species are killed (except by starving opossums)

Present forest destruction has two basic causes first, in the previous absence of herbivorous mammals, palatable tree species have grown in vulnerable compact stands which could not develop to-day , and secondly, euryphagous deer and goats, by the destruction of undergrowth, have both prevented forest regeneration and intensified opossum pressure upon the mature trees.

These investigations are continuing, and it is intended that full reports will be published later

[1] Lyne, A G , Pilton, P E , and Sharman, G B , *Nature*, **183**, 622 (1959)

[2] Hill, J P , *Proc Linn Soc N S W* , **24**, 42 (1899).

[3] Huxley, T H , *Proc Zool Soc Lond* , 649 (1880).

[4] Kean, R I , "The Evolution of Marsupial Reproduction" (unpublished)

[5] Sharman, G B , *Aust J Zool* , **3**, 56 (1955)

[6] Bowley, E A , *J Mammal* , **20**, 499 (1939)

[7] Bolliger, A , *J and Proc Roy Soc N S W* , **76**, 86 (1942)

[8] Kean, R I , "Natural Control in Populations of the Opossum *Trichosurus vulpecula* in New Zealand" (unpublished)

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 7

Institution of Electrical Engineers, Electronics and Communications Section (at Savoy Place, London, W C 2), at 5 30 p m —Mr B B Jacobsen "Frequency Patterns for Multiple-Radio-Channel Routes"

University of London (at King's College, Strand, London, W C 2), at 5 30 p m —Prof Max Derruau (University of Clermont-Ferrand) First of three lectures on the "Central Massif of France" * (Further lectures on December 8 and 10)

University of London (at Queen Mary College, Mile End Road, London, E 1), at 5 30 p m —Dr M Eigen (Max-Planck-Institut fur Physikalische Chemie, Gottingen) "Relaxation Spectra of Fast Chemical Changes in Solution" *

Manchester Literary and Philosophical Society (in the Reynolds Hall, Manchester College of Science and Technology, Sackville Street, Manchester), at 5 45 p m —Dr J Needham, F R S "Hydraulic Engineering and Society in Ancient and Medieval China" (Wilde Memorial Lecture)

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W 1), at 7 p m —Mr G Pask "Discontinuous Skill Teaching Machines"

Tuesday, December 8

Society of Chemical Industry, Agriculture Group (at 14 Belgrave Square, London, S W 1), at 10 30 a m —Dr T H Rose and Mr P H Brown "Experiments Comparing a Number of Conditions for the Improvement of Glasshouse Soils", Mr J Webber and Mr F W Shepherd "Experiments Comparing Bulky Organic Manures for Horticultural Crops", Dr F Haworth "Fertilizer Responses of some Vegetable Crops"

Institute of Marine Engineers (at the Memorial Building, 76 Mark Lane, London, E C 3), at 5 30 p m —Mr A Lindén "Recent Development of the Gotaverken Engine"

University of London (at Queen Mary College, Mile End Road, London, E 1), at 5 30 p m —Dr M Eigen (Max-Planck-Institut fur Physikalische Chemie, Gottingen) "Proton-conducting H-bond Systems and their Analogies to Electronic Semiconductors" *

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 5 30 p m —Dr L G Lajtha "Autoradiography in Bone Marrow Studies" (Fourteenth of fifteen lectures on "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation * (Further lecture on December 10)

Royal Aeronautical Society (at 4 Hamilton Place, London, W 1), at 7 p m —Dr E K Armstrong and Mr R E Stevenson "Some Practical Aspects of Compressor Blade Vibration"

Wednesday, December 9

University of London (at the Postgraduate Medical School of London, Ducane Road, London, W 12), at 2 p m —Dr J D N Nabarro "Laboratory Investigations in Endocrinology" *

Institute of Physics (at 47 Belgrave Square, London, S W 1), at 6 p m —Sir Edward C Bullard, F R S "Geological Time"

Society for Psychical Research (at Leighton House, 12 Holland Park Road, London, W 14), at 6 30 p m —Dr Letitia Fairfield "Children and Witchcraft"

Oil and Colour Chemists' Association, London Section (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W 1), at 7 p m —Dr S H Bell "Electron Microscopy and Paint Technology"

Society for Analytical Chemistry, Biological Methods Group (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 7 p m —Annual General Meeting, followed by Dr H J Wallis, Mr S S Kind and Dr A S Curry "Biological Methods in Forensic Science"

Women's Engineering Society (at "Hope House", 45 Great Peter Street, London, S W 1), at 7 p m —Dr Elizabeth Laverick "Radar and Telecommunications Research and Development"

Wednesday, December 9—Friday, December 11

Crop Protection and Pest Control Exhibition (organized by *World Crops*, at the Seymour Hall, Seymour Place, London, W 1)

Thursday, December 10

Institution of Electrical Engineers, Utilization Section (at Savoy Place, London, W C 2), at 5 30 p m —Mr D B Corbyn and Mr N L Potter "The Characteristics and Protection of Semiconductor Rectifiers"

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 5 30 p m —Dr Sheila T Callender, 'Iron Absorption" * (Last of the fifteen lectures on "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation)

Thursday, December 10—Friday, December 11

British Institute of Radiology, incorporated with the Röntgen Society (at Church House, Westminster, London, S W 1)—Annual Congress and Exhibition

Royal Society (at Burlington House, Piccadilly, London, W 1), at 9 30 a m daily—Discussion on "The Biology of the Southern Cold Temperate Zone" opened by Prof C F A Pantin, F R S

Friday, December 11

Royal Aeronautical Society (at the Institution of Mechanical Engineers, Birdcage Walk, Westminster, London, S W 1) —Symposium on "Flight Safety" (All Day Discussion)

University of London (at the Postgraduate Medical School of London, Ducane Road, London, W 12), at 4 p m —Prof A Haddow, F R S "The Present and Future Relationship of Cancer Research to Medicine"

Institute of Physics (at 47 Belgrave Square, London, S W 1) at 6 p m —Mr J F Sayers "The Ultrasonic Camera—an Alternative Approach to Ultrasonic Testing"

Institution of Electrical Engineers, London Graduate and Student Section (at Savoy Place, London, W C 2), at 6 30 p m — Sir Willis Jackson, F R S "The Trends of Electrical Progress and Their Implications"

Royal Aeronautical Society, Agricultural Aviation Group (at 4 Hamilton Place, London, W 1), at 7 p m —Mr Peter King "Aerial Operations Planning in the United Kingdom—Results and Difficulties"

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m —Prof R E D Bishop "The Menace of Vibration in Engineering"

Saturday, December 12

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S E 23), at 3 30 p m —Mr Philip Hunter-Jones "The Desert Locust" *

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Technical Officer (with a university degree or comparable qualification in physics or electrical engineering or other approved subjects) in the Department of Physics—Dr F B Kipping, University Chemical Laboratory, Lensfield Road, Cambridge (December 2)

Principal Scientific Officer (with research experience, preferably, but not essentially, in the chemistry of fats or related substances) in the Fats Research Laboratory of the Department of Scientific and Industrial Research, New Zealand, to undertake investigations on the composition and significance of fats and related substances, including phospholipids and sterols present in animal and plant tissues —The High Commissioner for New Zealand, New Zealand House, 415 Strand, London, W C 2, quoting Ref No B 11/21/22 and mentioning *Nature* (December 4)

Assistant or Associate Professor of Applied Mathematics—The Chairman, Department of Mathematics, McMaster University, Hamilton, Canada (December 10)

Lecturer or Assistant Lecturer (with at least a good honours degree in physics, and preferably experience in teaching and/or research) in Physics at the University of Malaya, Kuala Lumpur—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (December 15)

Lecturer/Senior Lecturer (with an honours degree in chemical engineering and some teaching or industrial experience) in Chemical Engineering at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, December 19)

Senior Lecturer or Lecturer in Pathology at the University of Khartoum—The Registrar, University of Khartoum, c/o Inter-University Council for Higher Education Overseas, 29 Woburn Square London, W C 1 (December 22)

Senior Technician or Technician in the Department of Bacteriology, and a Senior Technician or Technician in the Department of Surgery, University of Khartoum—The Registrar, University of Khartoum, c/o Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (December 22)

Entomologist, Grade C (with a good honours degree in entomology (zoology) and a particular interest in biological control work)—The Director, Institute of Biological Control, Science Building, Carling Avenue, Ottawa, Ontario, Canada (December 31)

Head (with a degree in electrical engineering or Corporate Member of the Institution of Electrical Engineers) of the Department of Electrical Engineering—The Principal, Coventry Technical College, Butts, Coventry (December 31)

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Telephone Number Whitehall 8831 Telegrams Phusis Lesquare London

Annual subscription £7/15/–, payable in advance,
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EXPANSION OF UNIVERSITY EDUCATION IN BRITAIN

IN an address to the eighth Congress of the Universities of the Commonwealth* at Montreal in September 1958, Sir Douglas Logan, principal of the University of London, opening a discussion on the establishment of new universities, expressed the opinion that in all parts of the world there is to-day a widespread demand for an expansion of the facilities for higher education which can be satisfied only by the creation of new universities. While he paid tribute to the way in which the scheme of 'special relation' had contributed to the growth in the post-war period of the new university colleges in the overseas Commonwealth, he pointed out that the scheme is costly both in time and man-power, making heavy demands on the university foster-mother. He believes, too, that in England we have reached the end of an era when apprenticeship under the London external degree system was the avenue by which an institution approached full university status, but nevertheless we are reaching the limit of expansion of our existing universities, and the problem of expanding facilities for higher education in the United Kingdom can, in his opinion, only be solved by the establishment of new university institutions.

Sir Douglas Logan believes that in this matter the initiative should come from outside, and that it is disappointing that the new University College of Sussex would only be the fifth to be founded in the United Kingdom since the end of the First World War. The founding of other university institutions is, of course, already being actively canvassed, for example, at York, at Norwich and at Bournemouth, and it will at once be realized that many aspects of long-term university policy are implicit in Sir Douglas's address. Apart from the question of where new university institutions should be established and how many, there are such questions as the size of a university, new or existing, what type or types of new institution should be established, the optimum size of its departments and faculties, their range of studies and, probably, the length of their courses. Nor can these questions be wisely considered without regard to Britain's existing resources, the desirable output of graduate and postgraduate students and the cover of faculties.

These questions have been the subject of increasing discussion in recent months. Early this year in *The New Scientist*, Prof. W. G. V. Balchin, of Swansea, argued that universities are a product of population and have risen in response to national, civic and regional needs. A new set of regional university colleges is desirable, he believes, to satisfy the future demand for places, to maintain the standards of existing institutions and permit experimentation. The belief is widely held that the optimum size of a university is between 3,000 and 4,000 students, but there is also strong support for smaller units of 2,000 to 2,500. Prof. Balchin listed a dozen or more regional centres for consideration where preliminary moves have been made.

The decision as to the number of new institutions must be determined by the desirable target for national output, as well as by the views held as to the appropriate size of individual institutions. The University Grants Committee has given a figure of 136,000 as a suitable objective for Britain before the end of 1960. The Association of University Teachers, however, estimates that the university population should rise to 176,000 by 1960, falling to about 145,000 a few years later. Present Government grants based on the first figure are expected to provide an annual output of 12,000 science and engineering graduates by 1970, and with 10,500 qualified men from the technical colleges, will increase the student-population ratio to something like 1 : 410.

To a large extent the argument for university expansion in Great Britain rests on the alleged need for more scientists and technologists, and the analysis of this need by Prof. John Jewkes in his presidential address to Section F (Economics) at the British Association meeting at York is accordingly highly important in assessing the desirable magnitude of university expansion as a whole. Inevitably, the striking of a right balance between the scale of scientific and technical activities and other activities is a matter of judgment, perhaps also of intuition. Prof. Jewkes suggests, in fact, that our knowledge about our scientific and technical effort is really very limited, and that we know little about even the true magnitude of the needs of Britain in man-power.

Prof. Jewkes does not believe that the universities of Britain are at present failing in their task of selection, and accordingly if more people are trained in them in the sciences and in technology, fewer of the ablest segment of the community will be trained in the other intellectual disciplines. This could be the more serious if there is, in fact, not simply in the undeveloped parts of the world, but also elsewhere, a growing need for more men of the administrative and managerial type, and for the pervasive spread of specialized skills of all kinds which Western countries take for granted. Indeed, important as it is that the administrator and manager should be aware of scientific and technical factors in a situation and able to assess their importance, it could equally be argued that the growing need of to-day is for the imaginative insight, the vision and capacity to assess human values that a humanistic education can inculcate—a view which President Eisenhower's

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* Eighth Congress of the Universities of the Commonwealth, Montreal, September 1–5, 1958. Report of Proceedings. Pp. xxix+100. (London: Association of Universities of the British Commonwealth, 1959.) 12s. 6d.

Science Advisory Committee appears to share in its statement, "Education for the Age of Science".

Here, indeed, the question of quality is all-important, and the possibility and consequences of still further increasing the proportion of failures (already higher in science and technology than in other subjects) in a policy of university expansion in which standards are not lowered must be considered. Here, too, it should be remembered that the decisive contribution to economic or industrial expansion and to scientific advance comes from the comparatively few outstanding and creative minds. The right question is undoubtedly, as Prof. Jewkes suggests, whether the community will gain by having more scientists and more technologists trained at the expense of non-scientists; but this too is linked with the question of quality and whether, in fact, we are at present employing our scientists and technologists to the best advantage and, in particular, providing them with the technicians and other assistance as well as equipment which are required to make the most efficient use of their services. Nor, as Prof. Jewkes also observes, can we overlook the competition which exists for the services of scientists, for example, between the need for teachers of science and scientists in industry or government service.

Prof. Jewkes is inclined to challenge the assumption that Great Britain is suffering from an unmet need for more scientists, and he is highly critical of the evidence or criteria on which the argument for such a shortage has been based. Neither international comparisons nor the attempts to correlate industrial output and the number of scientists and technologists are convincing; nor again does it appear reasonable to assume that, in proportion to size, every industry should spend the same proportion on research and development or devote the same proportion of its labour force to those ends. Measurement of the net gain arising from research and development is equally difficult, and there seems to be no strong evidence that the appearance of modern industrial research laboratories about 1930 has made any steeper the general upward trend in output per head. Again, comparing experiences of the different industrial countries since 1945 provides no very obvious correlation between the rate of industrial expansion and the resources devoted to scientific and technological effort.

Prof. Jewkes suggests, therefore, that we should continue to search for better criteria for determining how much the community should devote to science and technology, but points out that meanwhile the striking of a correct balance is not in itself a scientific process or one in which scientists should have the last word. He reminds us, moreover, that social discoveries in their totality may have contributed just as much to the rise of standards of living in the past two centuries as the technical inventions and scientific discoveries of the period. He does not suggest that we do not need more scientists and technologists; he does suggest that we should be clear as to the full implications of such expansion both in the universities and elsewhere, before we commit ourselves to a policy of expansion on any particular scale.

Lord Simon, in an article on university expansion in the *Universities Quarterly* of 1958–59 (13, No. 1), argued strongly for the establishment of a Royal Commission on the Universities to examine both university expansion and long-term university policy. He claimed that long-term university policy is scarcely considered by the University Grants Committee and that the Committee's very success in dealing with heavy and vitally important administrative matters leaves it little or no time to devote to matters of long-term policy. Lord Simon instanced many matters which such a body might consider, such as the question of halls of residence and the extent to which new universities should be primarily residential, and the relations between teaching staff and students, but without advancing convincing reasons why such matters should be considered by such a body as a Royal Commission rather than some appropriate committee appointed by the University Grants Committee itself.

There is, of course, involved here the fundamental question which Minister or Department of State should primarily be charged with university policy. Besides the Chancellor of the Exchequer, to whom the University Grants Committee is responsible, the Minister of Education and the Lord President of the Council are both involved; and Lord Hailsham has already made it clear that he regards university policy as to some extent falling within his new responsibility for fresh thinking about the whole structure of Britain's scientific and technical effort. This follows inevitably from his responsibilities for the Department of Scientific and Industrial Research. Such really prickly questions as the magnitude of the alleged distorting effects of the prestige and resources of the older universities in comparison with the new ones, and the implications and consequences of requiring a greater expansion in the scientific departments than academic circles regard as healthy for university life might well be handled by him without resort to the expedient of a Royal Commission, with its demands on men and women whose judgment, vision, authority and wide experience are already heavily engaged.

The question of a Royal Commission has again been raised by G. C. Moodie in a pamphlet issued by the Fabian Society. In "The Universities: a Royal Commission?"*, Mr. Moodie sets forth eighty-eight questions for consideration by such a commission without, however, seriously examining the justification for appointing a Royal Commission to consider all these matters, some of which are clearly comparatively trivial and others which Mr. Moodie himself admits could not usefully be examined by a purely United Kingdom Commission, since any action would necessarily have to be taken jointly by all the Commonwealth Governments involved. Here, it would seem that the Commonwealth Educational

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* The Universities: a Royal Commission? By G. C. Moodie. (Fabian Research Series, No. 209.) Pp. 52. (London: Fabian Society, 1959.) 5s.

Conference has already established the appropriate means. Indeed, of the seven questions dealing with Commonwealth relations detailed by Mr. Moodie, at least five or six came under consideration at the Oxford Conference last July.

It is only fair to point out that Mr. Moodie recognizes that not all the questions he lists need be answered by the proposed commission in detail, and that decisions on some might more appropriately be left to the University Grants Committee or the universities themselves. The terms of reference he proposes, however, are comprehensive: "to examine university education to-day, the role of the universities in modern Britain, and the ways in which the universities may best be enabled to fulfil that role in the foreseeable future; in making this examination to pay special reference to the number of students to be admitted to the universities, the internal government of the universities, the special positions within the nation of the Universities of Cambridge, London and Oxford, and the proper relationship with the public as represented by the institutions of Government, and with the rest of the educational system". He recognizes that the commission would require a special trained staff and that it would also need to make extensive use of sub-committees; but it is nowhere clear why, if the University Grants Committee were suitably strengthened on similar lines, it could not undertake the task at least as effectively. In any event, questions regarding the work of the University Grants Committee itself, its relations with the Treasury and the effectiveness of its control over the universities and of public accountability generally could only be satisfactorily handled by an independent body appointed by the minister concerned. Probably, as already suggested, this aspect could well fall within the review of the nation's scientific resources to which Lord Hailsham has already addressed himself.

From what Lord Hailsham has already stated, he intends to examine other questions which Mr. Moodie lists, such as the relations between the universities and the research institutes, the best means of encouraging university research, and the increase of private benefactions, particularly from industry, and for universities other than Oxford, Cambridge and London. Besides such problems of postgraduate study and research and the general financing of the universities, the specific questions listed by Mr. Moodie fall into three groups: specific problems of university expansion, including the limits imposed by the availability of qualified staff, problems of wastage, standards of admission, awards, residence and the like; the range and variety of university institutions; and university government and autonomy. The groups are not indeed sharply separated, but by and large the essential issues are clearly enough displayed; some large fields are expressly excluded, although they could be disregarded in any survey which sought to guide long-term university policy and particularly to influence the proportion of the national resources which should be allocated to the universities.

Whatever reservations may be entertained as to the means by which such questions as Mr. Moodie propounds should be examined, little exception can be taken to the propositions on which he affirms any university policy should be based. There will undoubtedly be an increasing number of school-leavers capable of profiting from, and demanding opportunities for, further education or instruction. The country needs more trained and highly trained citizens if it is not to decline into international insignificance and internal stagnation. Within any educational system, variety is essential and uniformity strongly antipathetical to choice and experiment, without which education must suffer in the long run. However these requirements are met, it will be costly, but it will be a productive and constructive form of national expenditure.

Of the first two propositions, it might be observed that further education does not necessarily mean university or higher technological education. The question of balance is as important as that of the amount of potential talent at present missed if full use is to be made of our resources of man-power—and incidentally, if the maximum satisfaction is to be given to the student not simply in his or her years of training but also in after-life. It might be added that due attention to this aspect is likely to afford the nation the most productive return from its expenditure on education at whatever level that is fixed.

Mr. Moodie is obviously opposed to the universities continuing to determine their own policies of expansion, and is dubious as to the alternative possibility of raising university standards and making wider use of other institutions for the less gifted. He seems to lean rather to a lowering of standards to something approaching the American level, though he admits that if this were done it would be essential to develop some institutions such as Cambridge, Oxford and possibly others to provide a particularly high level of education to highly selected students. He suggests that while this policy would mean that university education would become a comparatively common experience, this would be socially beneficial; and from this point of view would presumably repay the higher investment. Restriction of university entry by raising standards would also be beneficial, as it would ensure that the universities were not the only source of social leadership, and would allow them to stand more clearly for learning and research.

It seems likely that such fundamental issues as these will receive at least preliminary attention from Lord Hailsham, and if he considers that they need closer consideration by a Royal Commission, the recommendation would come with greater weight from his new position as Minister for Science. Probably in the first instance he will recommend, however, some further strengthening of the University Grants Committee so as to enable it to give more consideration to questions of long-term policy. The questions, however, of the effectiveness of the University Grants Committee itself, of the relations between the universities and the Government, the magnitude of the resources which should be placed at their disposal and the channels by which they should be made available are certain to be examined independently by Lord Hailsham. His comments and recommendations here will be awaited with as much eagerness and interest as his proposals regarding relations between the Minister of Education, the Chancellor of the Exchequer, the Lord Privy Seal and other departmental ministers, who are in some degree responsible by the training of scientists and technologists and the use of their services.

CURRENT RESEARCH ON REPRODUCTION AND FERTILITY

Studies on Fertility

Including papers read at the Conference of the Society for the Study of Fertility, London, 1958. Edited by Prof. R. G. Harrison. (Vol. 10 of the Proceedings of the Society for the Study of Fertility.) Pp. x+176. (Oxford: Blackwell Scientific Publications; Springfield, Ill.: Charles C. Thomas, 1958.) 25*s.* net.

Proceedings of the Third Symposium on Reproduction and Infertility

Colorado State University, Fort Collins, Colorado. Edited by F. X. Gassner, in association with Rue Jensen and H. J. Hill. (Sponsored by the College of Veterinary Medicine and the Agricultural Experiment Station.) Pp. viii+273. (London and New York: Pergamon Press, 1958.) 42*s.* net.

Essentials of Human Reproduction

Clinical Aspects—Normal and Abnormal. Edited by Prof. Joseph Thomas Velardo. Pp. ix+270. (London and New York: Oxford University Press, 1958.) 110*s.* net.

The Endocrinology of Reproduction

Edited by Prof. Joseph Thomas Velardo. Pp. viii+340. (New York and London: Oxford University Press, 1958.) 120*s.* net.

A NOTABLE feature of the new volume of "Studies on Fertility" is the publication of a group of papers on the use of synthetic progestins which, when administered orally, suppress ovulation and thus prevent conception in women. Dr. Gregory Pincus, one of the investigators originally concerned in the development of norethisterone (norlutin), norethynodrel (enovid), and similar compounds as potential oral contraceptives, reports favourably on the outcome of trials in Puerto-Rican women, and shows that a recovery of normal ovulatory function and fertility takes place readily after the cessation of medication. He, and Dr. Jackson, both mention, however, the disturbing side-effects of the oral medication, such as nausea, vomiting, dizziness, headache and abdominal pain which, though infrequent, yet require further investigation before synthetic progestins are adopted on a large scale as a safe and reliable means for the control of human fertility. Other papers in the same volume reflect adequately the various lines of advance in research on the physiology and pathology of human and animal reproduction. They cover a multitude of problems ranging from psychiatric and surgical aspects of human infertility to successful attempts of inducing conception in the guinea pig by injecting spermatozoa into the peritoneal cavity. Contributions to the physiology of gametes include new observations on the transfer of mouse eggs and on the effects of varicocœle, cryptorchidism, and ischæmia on testicular function in mammals, as well as new findings relating to the occurrence of some remarkable species differences in sperm metabolism of the boar, ram, stallion, bull and man.

The volume is a good example of progress achieved by an interchange of ideas and observations between clinical investigators, concerned primarily with the problems of human fertility, and the laboratory workers whose efforts are concentrated in the main on the more basic problems underlying the reproductive processes in animals. Now that the recently announced *Journal of Reproduction and Fertility* is going to replace the "Studies in Fertility" as the official organ of the Society for the Study of Fertility, one hopes that its editors will be able to extend even further the range of papers, while maintaining in the new publication the standard which distinguished the parent journal.

Like "Studies in Fertility", the Proceedings of the Symposium on Reproduction and Infertility, held under the auspices of the Colorado State University, illustrates well the tendency among research workers in the field of reproductive physiology to pay increasing attention to comparative aspects, in an endeavour to link up studies on human and animal fertility. Of the twenty papers given at that symposium, more than half deal with problems in cattle, mainly with the incidence and causes of vibriosis, vaginitis, malignant tumours of genital organs, and sterility of the so-called repeat-breeder cow. Those interested in human reproductive disorders will find especially interesting and instructive the chapter by Nowakowski, on the classification of male hypogonadism, based to some extent on the chemical analysis of semen, and Reifenstein's survey of new long-acting progestins and their use in maintaining human pregnancy and preventing abortion.

Progress in research concerned specifically with human reproduction naturally forms the main theme of "Essentials of Human Reproduction", a text-book written by thirteen specialists representing various medical schools in the United States, and edited by Prof. Velardo, of the Yale University Medical School. An attractive feature of this book and its companion volume, "The Endocrinology of Reproduction", is the emphasis which the authors have placed on existing problems in the physiology of reproduction and on current research problems. Both books are, moreover, notable for the inclusion of numerous illustrations, some of them reproduced from the monumental "Ciba Medical Illustrations" of Netter, others originating from Robert Wabnitz. "Essentials of Human Reproduction" contains discussion of all the main stages of the normal reproductive process in man, and tackles in addition the various disturbances of human pregnancy, endocrine disorders of the testis and ovary, and different forms of infertility. "Endocrinology of Reproduction", written alike for research students and specialists, includes, in addition to chapters on male and female endocrinology, some information on closely related subjects such as the genetics of reproduction and the anatomy and embryology of the male and female reproductive systems. As with most text-books written by several authors, there is a certain amount of overlapping. Research students will also find that some chapters of the text-book are much easier to follow than others, and they may have some difficulty in deciding which of the copious references should be selected for further reading. This, however, does not detract from the value of the book to the specialist, both as a concise and up-to-date survey of the subject and as a useful compilation of relevant literature T MANN

FORMALIZATION OF CONSTRUCTIVE CONCEPTS

Constructivity in Mathematics

Proceedings of the Colloquium held at Amsterdam, 1957 Edited by Prof A Heyting (Studies in Logic and the Foundations of Mathematics) Pp viii+297 (Amsterdam · North-Holland Publishing Company, 1959) 60*s*

THIS volume consists of 25 articles by 23 authors The central themes are intuitionism and inductive definitions The two fundamental steps in the background are Heyting's formal systems to embody Brouwer's ideas on logic and mathematics, and a classical formalization of the concept of effectively calculable functions by general recursive functions As a result of these steps, a more formal treatment, congenial to the logician, of intuitionism and constructive mathematics in general becomes possible Much of the book is devoted precisely to questions arising from such a treatment Since in classical mathematics we are concerned with not only natural numbers but also real numbers and real functions, a major problem is to extend the notion of recursive functions to those of objects of higher type, that is, to define computable or constructive functionals Kleene's paper on countable functionals, the papers by Davis, and by Kreisel–Lacombe–Shoenfield deal with this problem In addition, Kreisel and Kleene each gives an interpretation of intuitionistic analysis by applying constructive functionals

Another problem is to 'reconstruct' classical mathematics by restricting arbitrary functions to constructive ones This leads to the study of constructive, in particular, recursive, analysis and topology The articles by Goodstein, Grzegorczyk, Lacombe and Specker are taken up by this The three papers by Rasiowa and Sikorski are concerned with formal considerations on Heyting's calculus of intuitionistic logic

Fitch gives a consistent formal system which contains the theory of combinators and "extended basic logic" Myhill proves theorems on "finitely representable functions" which appear to be essentially the same as the Herbrand recursive functions reported in Godel's lectures of 1934 Hermes and Wette study certain problems about the "operative" logic and mathematics

The remaining nine articles are of a more general or a more philosophical character Heyting makes some familiar but pertinent remarks on intuitionism , Beth comments on his own formal treatment of the intuitionistic logic Kalmár argues against the hypothesis that every effectively calculable function is general recursive , Péter disputes that every general recursive function is indeed effectively calculable Lob tries to formalize concepts such as event, brain, subject, mental occurrence of a subject, perception, in terms of constructive ideas Nelson considers the meaning of falsity in empirical characterizations of truth, as well as the situation that classical logic identifies certain constructively distinct entities Lorenzen stresses the importance of inductive definitions for constructive mathematics Mostowski discourses on various degrees of constructivism Bernays gives a free-variable, complete formal system as a natural extension of the calculus of relations

If we summarize the concepts and methods of foundational studies under the five headings of anthropologism (strict finitism), finitism, intuitionism, predicativism (inductivism), and platonism, the book is mainly concerned with intuitionism and a part of predicativism This is perhaps not surprising since platonism falls outside the domain of constructivity, while the principles of anthropologism and finitism are not yet sufficiently clarified to admit a direct mathematical handling HAO WANG

BIRDS OF PREY

Pirates and Predators

The Piratical and Predatory Habits of Birds By Colonel R Meinertzhagen Pp ix+230+44 plates (Edinburgh and London Oliver and Boyd, Ltd , 1959) 70*s* net

THE author of this handsome volume emphasizes that it is a contribution and not a monograph The value indeed lies in the record of original observations made in the course of long experience in Europe, Africa and Asia Economical of words, the writer has a happy knack of conveying a vivid impression of what he has seen His touch is less sure when he cites the records of other observers, but in any event he disclaims an exhaustive representation of the literature

An opening chapter deals with various general points, such as the food preferences of individual members of a predatory species, the regular beats and hunting territories of some, relative size of the usual victims, methods of killing and of preparation for eating, and the reactions of other birds to predators Throughout, particular attention is paid to the occurrence of 'piracy', that is to say one species robbing another of its prey, occasionally in some instances and regularly in others The habits of mammals and reptiles receive frequent mention

Group by group, Colonel Meinertzhagen then briefly reviews predatory and piratical habits among the birds which he rather whimsically classes as 'amateurs', those outside the Falconiformes and Strigiformes Species by species he next deals with many of the 'professionals', the true diurnal and nocturnal birds of prey in which he is especially interested This is the longest section of the book and covers examples of hunting for many types of prey—insects, molluscs, fish, reptiles, birds and mammals—some species being highly specialized in this respect and others more versatile Flying prey may be secured by level pursuit or by 'stooping' from above prey on the ground may be located from flight (quartering, soaring, hovering), from a perch or from the ground itself (secretary-bird) , then there are the fishing hawks, the eaters of carrion and the partly vegetarian palm-nut vulture One would have welcomed some sort of general review of these topics, in addition to the piecemeal presentation

Finally, there is a chapter on what the author terms 'autolycism', that is to say, making use of other animals (including man) but not as victims There are the many birds which nowadays usually nest on buildings or which have developed feeding habits geared to human activities There are various associations of birds with mammals, both wild and domesticated, exemplified by the habits of the cattle egret and the ox-peckers There are associations between different species of birds, and breeding parasitism is just mentioned As regards associations with reptiles, Colonel Meinertzhagen has personally witnessed both *Pluvianus* and *Hoplopterus* picking the teeth of crocodiles

The colour plates are mostly from pictures by the late George Lodge, but one of a lammergeier from a tapestry by the author is of note ; the drawings and photographs are from various sources

Landsborough Thomson

KEEPING UP TO DATE WITH CHROMATOGRAPHY

A Manual of Paper Chromatography and Paper Electrophoresis

By Richard J Block, Emmett L Durrum and Gunter Zweig Second edition, revised and enlarged Pp xi+710 (New York Academic Press, Inc , London Academic Books, Ltd , 1958) 12 80 dollars

Papierchromatographie

Von Dr Friedrich Cramer Vierte, stark erweiterte Auflage (Monographien zu "Angewandte Chemie" und "Chemie-Ingenieur-Technik", Nr 64) Pp 215 (Weinheim/Bergstr Verlag Chemie, GMBH , 1958) n p

Handbuch der Papierchromatographie

Herausgegeben von Dr I M Hais und Dr K Macek Band 1 Grundlagen und Technik Pp xxiv+860 (Jena Gustav Fischer Verlag, 1958) 58 40 D M

Chromatographic Reviews

Progress in Chromatography, Electrophoresis and Related Methods, Vol 1 Edited by Michael Lederer Pp ix+276 (Amsterdam Elsevier Publishing Company , London D Van Nostrand Company, Ltd , 1959) 45*s*

PREVIOUS editions of two of these books are already well known The new editions of Block, Durrum and Zweig's "Manual" and of Cramer's "Papierchromatographie" maintain the high standard of their predecessors Both incorporate recent information and improvements in arrangement of subject-matter Because they are about subjects that are still growing rapidly, it is not surprising that these books are somewhat larger than previous editions Block, Durrum and Zweig's book is half as big again as their first edition of 1955, and has become rather bulky for a practical manual Cramer's book has also put on weight but it is still slim enough to carry around the laboratory without undue strain Cramer's exposition of paper chromatography remains less highly detailed and he deals only in outline with paper electrophoresis, whereas Block, Durrum and Zweig are faced with the problem of coping adequately with both techniques within the covers of one book Block and Zweig's section is a detailed and up-to-date account of the paper chromatography of very many substances, amply illustrated with photographs, diagrams and tables of R_F values The bibliography covers the literature up to the end of 1956 and occupies no less than 45 pages New features in Durrum's section on paper electrophoresis include recent developments in recording and integrating densitometers, radioactive scanners and improvements in curtain electrophoresis and other methods All the theory is now covered in one chapter instead of being split up as previously There is also a very full bibliography (about 2,000 references as compared with 300 in 1955) and a useful classification of electrophoretic applications Cramer's book covers much of the subject quite adequately for most purposes It is also well illustrated and has many tables of R_F values The colour reproductions are extraordinarily good The book is attractively printed and will appeal primarily to German-speaking workers

In 1954, under the editorship of Hais and Macek, the comprehensive Czech treatise "Papirova Chromatografie" was published Afterwards, the editors decided to prepare a new edition of this work in two volumes, the first to cover fundamentals and techniques, the second to cover applications and bibliography Also a German translation of this new edition was planned, and Vol 1 in German was published in August last year However, the original Czech edition, which I have not seen, was published only a few months ago Comparing the first Czech with this German edition, the conversion has been accompanied by a great improvement in appearance and the quality of printing and paper is now high There is no doubt that this massive work (mistakenly entitled "Handbuch') is the most complete exposition of paper chromatography that exists Theoretical aspects are dealt with fully and the many methods and applications are covered with remarkable thoroughness A number of features deserve mention There are supplements to every chapter and all are collected together as an appendix which gives full directions for preparing location reagents, for pretreating substances before chromatography and for pretreating paper when special modifications of chromatography are required Many of the R_F values are conveniently recorded in diagrammatic form There are excellent surveys of methods for structural analysis of large molecules, particularly proteins The book is published in Eastern Germany and copies may not be easily obtained in Western countries, though I have been informed that there is no such difficulty in Western Germany

It is striking how frequently new editions of books on chromatography are appearing Cramer's is the fourth since 1951, Block, Durrum and Zweig's is the third since 1952 if the "Manual" published that year by Block, Lestrange and Zweig is regarded as the first edition Hais and Macek's is the second in four years It would appear that authors of such books are obliged to think about preparing new editions as soon as they are published Nevertheless, for many and perhaps most purposes the earlier editions are still quite adequate and indeed they are largely incorporated unchanged in the new editions (It must also be admitted that some of the subject-matter has become dead wood, but there seems to be a reluctance to cut it out) The admirable efforts of the authors to keep their books on the whole field of paper chromatography abreast of the times may eventually prove to be an impossible task, because the subject continues to grow at an ever-increasing rate The alternative is to select a limited number of topics and give as much information as possible about each This is the purpose of Lederer's "Progress in Chromatography" and Vol 1 is the first of a series to be published at intervals (how frequently is not stated but presumably yearly) The series will be concerned with all forms of chromatography and with related methods, including electrophoresis For this volume some of the articles have been specially written while others are taken from the *Journal of Chromatography* and all are in English There are nine articles each contributed by specialists Two are concerned primarily with techniques, namely, "Chromatostrips and Chromatoplates" (Demole) and "High Voltage Electrophoresis" (Michl) Both are most useful contributions because the first describes an elegant technique which deserves wider recognition and the second deals with a method which is attracting more and more interest The other articles are on chromatographic and electrophoretic methods applied to the following special groups mould metabolites (Reio), strychnos and curare alkaloids (Marini-Bettolo and Casinovi), sterols and steroids (Neher)—probably the most thorough survey of this group that has been written—chloroplast pigments (Šestak), anthocyanins (Harborne), inorganic phosphorus compounds (Hettler) and isotope separation (Chemla) For anyone interested in these topics, the articles offer very detailed well-presented and up-to-date information If future volumes maintain as high a standard as Vol 1, the series will undoubtedly form a most valuable contribution to the literature of chromatographic and related methods

R Consden

NEW TECHNIQUES IN PACKAGING

Pressurized Packaging (Aerosols)

By A. Herzka and J Pickthall Pp xi+411 (London. Butterworths Scientific Publications, New York Academic Press, Inc, 1958) 63*s*

THE pressurized pack is a method of packaging and dispensing small quantities of a large variety of materials and has developed rapidly in recent years For products like hair lacquers it is probably ideal, for many others it is efficient and convenient, but expensive, and the relatively high cost may or may not offset its many advantages The pressure pack of horticultural insecticide is excellent for treating a treasured plant, but for pest control on a large scale gardeners who are not millionaires are soon forced back to the old bucket of derris

Herzka and Pickthall's book is an encyclopædia of the subject and is in fact source book, laboratory handbook, trade directory and recipe book all in one A short general section explains the general methods of operation of two-phase and three-phase systems Section B deals with propellants, containers, valves, methods of filling and the laboratory checking of finished packs from the points of view of safety, (in)flammability, spray size and pattern, moisture content, etc A considerable mass of information is collected together in its numerous tables and graphs Section C gives detailed instructions for the pressurized packaging of products ranging from foodstuffs to paint strippers, cosmetics to anæsthetics The special precautions necessary in packaging these different commodities are described and ample recipes are given The volume concludes with a glossary of abbreviations and technical terms, trade names of materials and suppliers, patents, particulars of industrial methylated spirits and a world list of suppliers of containers, valves, propellants, sealing equipment, laboratory apparatus, etc There are both author and subject indexes

This is a valuable reference work, well produced and printed Errors are few The illustrations are the weakest part Some of the line drawings are confusing, with the essential parts on too small a scale for it to be clear how the mechanism operates (for example, Figures 64 and 65) Not a few of the half-tone illustrations are of poor quality and not very informative These are, however, minor blemishes in a work that, containing much information in small compass, deserves wide circulation

V G W Harrison

TECHNOLOGISTS AND TECHNICIANS

Sandwich Courses for Teaching Technologists and Technicians

By Dr P F R Venables With a contribution by R Ratcliffe Pp 160 (London Max Parrish and Co, Ltd, 1959) 18*s* net.

DR P F R VENABLES is one of the most able practitioners and protagonists of technical education in Great Britain and his speeches and writings are treated with deserved respect In this, his latest publication, he has collected information about the so-called 'sandwich' courses for producing technologists and technicians which have grown up in such mercurial fashion over the past few years This information is set down with characteristic vigour and supported by views which are never lacking in candour or clarity Whether the book will have much vogue, however, is open to question Much of it contains information about routine administrative procedure necessary for running successful sandwich courses and will be already quite familiar to those concerned with running such courses

Where the book is likely to make an impact is among those principals of smaller technical colleges who are determined not to be left off the 'sandwich band-wagon' and who appear to put the prestige of their colleges before the genuine interests of their students Dr Venables makes it very clear that many higher national diploma and college associate courses would never have come into being if regional advisory committees had carried out their commitments with courage to repel over-ambitious local projects He also makes it clear that the time has come when colleges of advanced technology should take their rightful place alongside universities, heads of departments should become professors (has he not heard of the Royal Technical College, Glasgow, and Manchester College of Technology ?), eminent industrialists and technologists should be appointed to the part-time staffs as consultant professors, and research fellowships should be readily available to those more interested in teaching than research

Few would deny the strength of Dr Venables's arguments and most concerned with the progress of technical education in Great Britain would support him Perhaps his views about sandwich courses and related matters would have carried greater weight, however, if he had left the preparation of this book until sandwich courses had emerged from their swaddling clothes

Automation and Society

Edited by Howard Boone Jacobson and Joseph S Roucek. Pp. xiv+553. (New York Philosophical Library, 1959.) 10 dollars

A RESOLUTION accepted by the House of Commons on May 1 in a debate on automation requested the Government to undertake an intensive study of the probable consequences of its introduction and to invite industry to co-operate in effecting the necessary changes with a minimum of hardship to its employees. In the debate, which was concerned largely with the bearing of automation on employment, reference was freely made to the report on the technical trends of automation and their impact on management and labour issued by the Department of Scientific and Industrial Research some three years ago and to subsequent inquiries in this field which have been supported by the Department The present book does not provide the type of report which was visualized in the debate as contributing most decisively to co-operation but the sections dealing with automation and responsibility and with automation and society could assist that task of education or increasing the public understanding upon which alone such co-operation can be firmly based Apart from the first, in which Mr P T Veillette outlines very clearly the development of the concept of automation, the sections of this book are the composite work of some thirty authors, that on automation applied dealing specifically with its application in some fourteen fields in the United States The other two sections are of greater interest to British readers, but on the whole they scarcely bring out the social implications any more clearly than was done in 1950 by the Department of Scientific and Industrial Research's report The section on automation and society includes a useful dictionary of automation, but the 37 short case-histories of automation in the United States of America and Canada compare poorly with the three case-studies in automation published by Political and Economic Planning in 1957 It is difficult to believe that the book could not have been considerably compressed with great advantage, and the inclusion of brief biographies of contributors does not compensate for the omission of an index or for the scattering of selected bibliographies, some annotated, at the ends of chapters

R BRIGHTMAN

Metal Fatigue

Edited by Dr J A Pope Pp. xiv+381 (London Chapman and Hall, Ltd , 1959) 70*s* net

READERS of Nevile Shute will probably be surprised to realize that the unreceptive attitude of engineering designers to Mr Honey's ideas on fatigue was until fairly recently an authentic picture of the state of affairs in the engineering industry Several unfortunate aircraft crashes, which were proved to be initiated by fatigue failure, have, however, been in part responsible for a change of heart, and the more forward-looking engineers are now very much exercised by the problem of making allowance for the effects of vibrational stress on their structures Their task of producing a safe but economical design is not easy ; the amount of reliable data which are available is at present inadequate and, since several uncontrolled variables affect the fatigue life, a statistical approach is essential The volume under review should be a real help , it reproduces twenty lectures given in the Engineering Department at the University of Nottingham during a Summer School on the Fatigue of Metals The professed aim of the editor is "to present to practising engineers the known facts about metal fatigue and its effects on design" This is therefore a book primarily for engineers, although much of it will be read with profit and fascination by metallurgists and others interested in the wayward behaviour of stressed solids

The work is divided into three main sections the basic phenomena and, so far as it exists, their explanation , fatigue properties of engineering materials and components , and fatigue testing of engineering components The fifteen contributors have produced a readable, clearly presented and useful picture of the state of knowledge in 1955 The engineering designer will draw some comfort from a perusal of the book, particularly from the realization that the problems of fatigue, as they affect him, are being subjected to competent and energetic scrutiny He will see that already in some directions solid progress has been made, notably in our knowledge of the true stress intensification at cracks and notches, but he may wonder what further developments have taken place in the four years between the compilation of the material for the lectures and the appearance of this book.

K M ENTWISTLE

Principles of Modern Physics

By Prof Robert B Leighton. (International Series in Pure and Applied Physics) Pp xii+795 (London: McGraw-Hill Publishing Company, Ltd , 1959) 97*s*

THIS addition to the present series is most welcome The author has tried to write a book suitable for students of physics in their final year and for specialists in other subjects who require a broad general background It caters very well for the former group By assuming a considerable background of mathematics and classical physics a great deal of tedious digression, common in other books, is avoided The special theory of relativity, once relegated to an appendix, has, at last, achieved its rightful place—the first chapter , atomic and molecular spectroscopy, so often the major topics, are confined to about seventy pages More than one-third of the book is devoted to nuclear physics The book is very comprehensive and up to date It includes such topics as parity, band theory of solids and X-ray diffraction Work published as recently as 1958 is referred to Occasionally, the material becomes too condensed for easy reading, but frequently the exercises are very well designed to supplement the text. Other exercises vary from simple logical extensions of the preceding sections to difficult problems which only a very good student could be expected to solve without assistance Rationalized M K S A units are used throughout the book, although some of the formulæ are also given in what must still be regarded as their more familiar form, and there is a useful appendix of atomic constants in M K S A units

E STANLEY

Directory of Nuclear Reactors

Vol 1 . Power Reactors Pp ix+214 (Vienna International Atomic Energy Agency, 1959) 73 50 schillings , 21*s* , 3 50 dollars

THIS directory makes available the important details of power-reactor projects, throughout the world, which will be producing electric power by the end of 1962 , reactors with an electric power output of less than 2 MW are not included Information is presented for each reactor under the following headings general, reactor physics, core, fuel element, heat transfer, control, reactor vessel, fluid flow, shielding, containment, turbo-generator, cost and staff In almost every case diagrams are also provided of the fuel element, two sections of the reactor, and the fluid-flow sheet for the system The information is as up to date as can be hoped for , in every case, except one, it is dated between December 1958 and April 1959 Useful conversion charts and space for notes are also provided The directory is comparable with a similar compilation published a month earlier by the American Society of Mechanical Engineers It is better than the American publication in that the information on any particular reactor is fuller and more reactors are covered, for example, the Russian reactors are included

The book is very good value for its price, but a more substantial backing would be an improvement as the present one is very liable to damage A minor point is that a conversion scale from mills to pence would also be a help The few mistakes noted were all trivial In general, such a directory is required, the International Atomic Energy Agency appears to be the best organization to carry out such work, and the first volume is a good start A J SALMON

The Birds

By Oskar and Katharina Heinroth English edition prepared by Michael Cullen Pp 175 (London Faber and Faber, Ltd , 1959) 18*s* net

ORNITHOLOGY provides many fascinating problems, such as how birds mate, migrate, eat, sleep, and so on, which are a source of interest to an increasing number of people Lack of easily available and authoritative information has given rise to a number of popular misconceptions Mr Cullen states that Oskar Heinroth knew this because of his contact with people at the Berlin Zoo, where he was curator for many years That is the reason given for the book which Heinroth published in 1938 and which was revised by his wife in 1954 after his death in 1945 It is said that in this English edition certain parts of the text have been brought up to date

Though mainly and intentionally limited to certain aspects of bird biology in which Heinroth was particularly interested, for example, the development of nestlings, a wide range of information is provided which will satisfy the curiosity of many who want to know more about birds than merely their names There is ample scope for works of this kind, which are singularly lacking among the numerous bird-books Although appreciating the value of this one and the skill of the translator, one regrets that a need should have to be satisfied in this way, for translations, inevitably, lack the freshness of original thoughts It is a pity that the wealth of present-day photography was not used to give the illustrations a modern look

Mineralogical Study on Clays of Japan

By Dr Toshio Sudo Pp vii+328 (Tokyo Maruzen Co , Ltd , 1959) 2,000 yen ; 10 dollars

THOSE who have followed the recent literature on the clay minerals of Japan will be aware of the outstanding contribution made by Dr Sudo and his collaborators They will probably welcome, as does the reviewer, this collected account of his researches Although much of this material has already been published in various Japanese and foreign journals, its re-publication in volume form is justified on grounds of convenience in reference

The author has been quite uninhibited in his approach, and this book, being a report on research in progress, will inevitably be found wide open to criticism on many points Numerous details will have to be revised later, by the author himself or other workers But in its imaginative application of up-to-date techniques, the book is almost a model In most chapters, the reviewer found things to set him thinking along new lines, as well as things to disagree with

Most of the book is devoted to specific minerals and clay deposits The first seven chapters are general in nature, and the reviewer feels less happy about them Arguments, at times hard to follow, often seem to tail off inconclusively

The presentation is excellent, but the book needs an alphabetical index, even though there is a very full table of contents The language is, alas, only adequate at best, and at worst verges on unintelligibility The number of printing errors is more than would be tolerable in an English or American book We cannot expect authors to be expert linguists Surely the blame rests with the publishing house, which is one of international repute If they publish in English, they should ensure that adequate linguistic assistance is available D M C MACEWAN

Progress in Organic Chemistry

Vol 4 Edited by Dr J W Cook (Progress Series) Pp ix+256 (London Butterworths Scientific Publications , New York Academic Press, Inc , 1958) 50*s* , 8 80 dollars

THE choice of subjects for this volume is significant in that it reflects the present dominating position of natural products in organic chemistry Also symptomatic of current thinking is the inclusion of biogenetic considerations in both a predictive and interpretative role Of the four chapters devoted to natural products the most extensive is a very fully documented account by A H Cook and G Harris on the degradation and synthesis of peptides and proteins F D Gunstone reviews naturally occurring unsaturated fatty acids Notable here are the stereospecificity of recent synthetic procedures and the large emerging group of acids from compositous plants and micro-organisms, presenting a spectrum of ethylenic, acetylenic and allenic unsaturation

2-Acylcyclohexane-1 3-diones from sources as diverse as the male fern, hop resins and certain essential oils are discussed by C H Hassall in a chapter which also includes the widespread lichen constituent usnic acid, the recent synthesis of which underlies the probable role of oxidative phenolic coupling in biosynthesis That this concept may have wider significance is apparent from recent work on the spirocoumaranones griseofulvin, geodin and erdin which, together with methylene quinones, chromenopyrones and depsidones, are included in a chapter by W B Whalley on oxygen heterocyclic fungal metabolites F G Mann surveys recent syntheses of phosphorus, arsenic and antimony heterocycles, mostly from his own laboratory B and A Pullman contribute a theoretical discussion of free valency and correlate it with a selection of physical and chemical properties in aromatic hydrocarbons Once again the chapters of this book reflect the erudition and enthusiasm of experts discoursing within their chosen fields of interest K H OVERTON

RECENT WORK ON THE ELECTRON MICROSCOPY OF VIRUSES*

By DR. KENNETH M SMITH, C B E, F.R S
Agricultural Research Council Virus Research Unit, Cambridge

THE conception of a virus as a mysterious, almost supernatural, entity dating from Mayer's studies on tobacco mosaic virus in 1886 persisted up to quite recent times, and learned discussions were held as to whether viruses were particulate or not No one, however, suggested what they were if they were not particulate, and Beijerinck's famous conception of a "contagium vivium fluidum" was still quoted As lately as 1932, T M Rivers stated with a good deal of justification that the size of no virus was accurately known

The first indication of the shape of a virus was given by two American workers, Takahashi and Rawlins, in 1933, who observed that the sap of a tobacco plant infected with the mosaic disease showed the phenomenon of double refraction when made to flow and viewed by polarized light This indicates that the sap contained rod-like entities, an observation amply confirmed in later years

Apart from the so-called elementary bodies of certain animal virus diseases which came within the resolution of the optical microscope, the first actual pictures of a virus particle were made by Barnard with his ultra-violet light microscope It was only possible, however, to resolve some of the larger animal pox viruses, and no details of the particles could be seen It was not until the invention of the electron microscope that any conception of what a virus really looked like was obtained

The improvements in the electron microscope and the developments in the techniques for the study of viruses during the past ten years have been very great, and it is only possible to indicate them here without any technical description

The first virus to be observed on the electron microscope was that of tobacco mosaic, and the particles were shown to be rod-shaped, as had been predicted earlier by other methods The first electron micrographs of this virus showed only that it was a rod-shaped particle and no other details were visible It is by comparing these early pictures with modern electron micrographs of the same virus that some idea is obtained of the great advances which have been made in electron microscopy

Metal Shadowing

Williams and Wyckoff[1] developed a method of shadow-casting in which metal, evaporated from an electrically heated filament in a vacuum, impinges on a specimen from a sufficient distance so that the metal atoms arrive in almost parallel straight lines The metal, being more opaque to the electron beam, casts a shadow, thereby giving a three-dimensional effect to the objects ; this gives micrographs which are a great improvement on the flat and rather characterless pictures previously obtained Metals for shadow casting should not show a granularity which might obscure the structural detail of the object ; several have been used, and they include chromium, gold and platinum alloys, and uranium

Thin Sections

The development of the ultra-microtome for cutting ultra-thin sections has marked a great advance in electron microscopy In the early days sections were cut at a high speed and of a wedge shape, the thin end only being examined Nowadays, however, the technique has become almost ordinary laboratory procedure There are various types of ultra-microtomes on the market ; one or two still make use of steel knives, but the glass knife, made by fracturing a strip of plate glass, is more widely used Recently, the diamond knife, made from a polished industrial diamond, has become popular The advantages of this are its extreme hardness, its durability—it can be used continuously instead of only once as with the glass knife—and its suitability for cutting hard objects Very fine results have been achieved with the diamond knife but it requires great care in its manipulation (Figs 1 and 2)

A good operator with either glass or diamond knives should be able to cut sections of 300–400 A in thickness

The embedding medium is important, the most popular being a plastic made by the polymerization of butyl and methyl methacrylate[2] Other media are 'Vestopal' polyester resin[3] and 'Araldite' epoxyresin[4] ; all these require dehydration with ethanol Just recently, however, another embedding medium, to which the name 'Aquon' is given, has been described ; this medium is miscible in water and avoids the necessity of using dehydrating agents[5]

New Staining Methods

The standard method of fixing virus materials for electron microscopy is to use buffered 1 per cent osmium tetroxide, and this acts as a stain as well as a fixative Recently, however, a number of new staining techniques have been developed ; one of the most successful of these is phosphotungstic acid, and Selby[6] has used this acid at a concentration of 1 per cent adjusted to pH 5 4 Other useful stains are 1 per cent phosphomolybdic acid buffered at pH 5 4 with phthalate buffer[7], chrome gallocyanin[8], 0 1 M ferric chloride[9], mercuric bromophenol blue[10] and 0 5 per cent uranium acetate buffered at pH 6 1 with veronal acetate buffer[11] The last-named has proved very successful with insect virus sections

Supporting Films

For several years the standard supporting film on the grid was one of collodion or 'Formvar', and these are still used for routine work The increasing resolution of the electron microscope and the decreasing thickness of the sections, however, led to

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* Substance of a University of London Special Lecture delivered on October 29

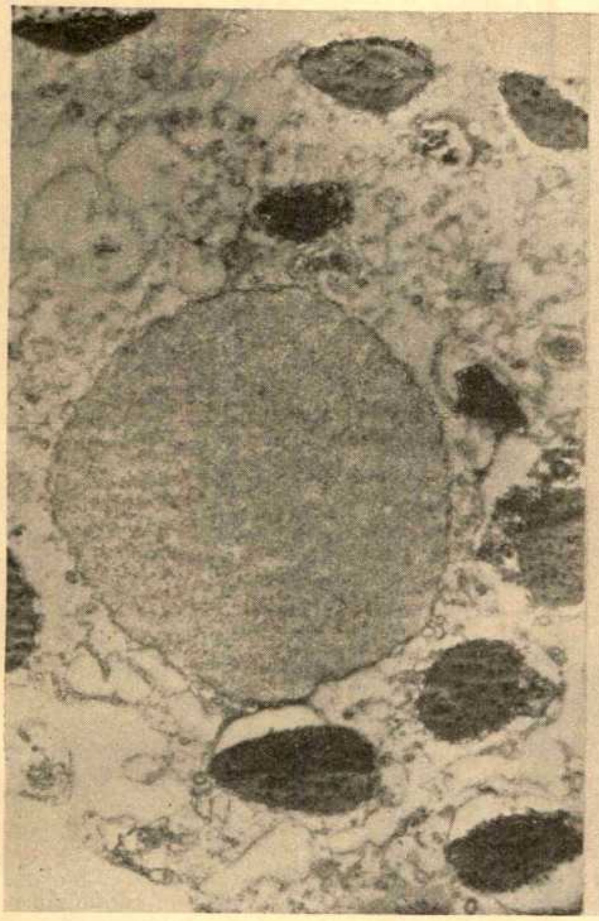

Fig. 1

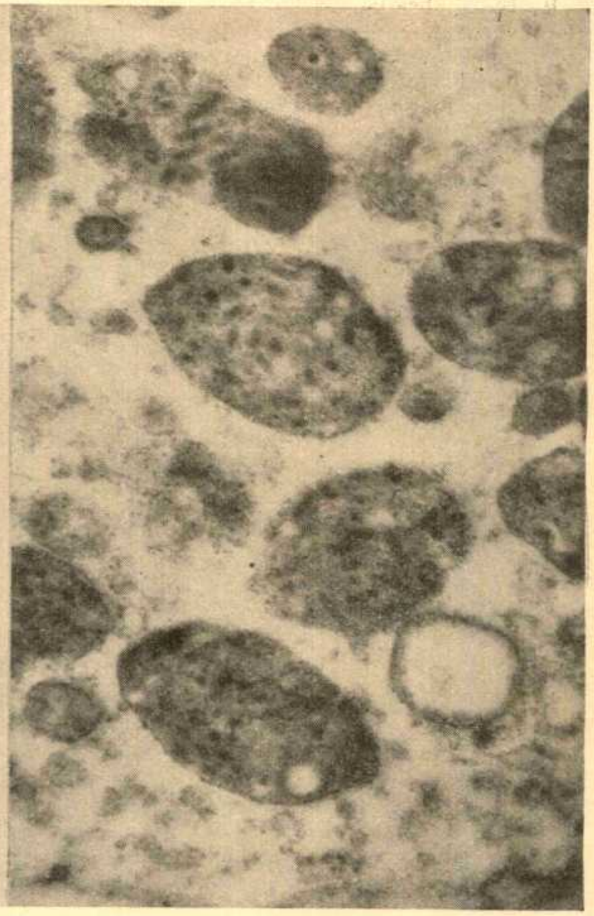

Fig. 2

Fig. 1. Ultra-thin section of a blood cell from the larva of *Tipula paludosa*, the crane fly, infected with a nuclear polyhedral disease ; the virus has left the nucleus where it develops and has become occluded in the polyhydral crystals surrounding the nuclear membrane. × 10,000

Fig. 2. Similar section to Fig. 1 showing peculiar virus inclusions in the blood cell. × 49,000

difficulties and it became necessary to find another substrate. Carbon films[12] made by boiling carbon in a vacuum have proved very satisfactory ; they have virtually no structure to confuse the issue at high magnifications, and they are more resistant to the electron beam and do not volatilize and foul the gun.

Carbon Replicas

Several replica techniques have been devised since the electron microscope became a laboratory tool, but except for specialized work the carbon replica has proved the most successful. This technique was first suggested by Mühlethaler, but has been brought to its present high standard by Bradley, working at the A.E.I. Research Laboratory at Aldermaston. The carbon replica technique is a single-stage process in which the suspension of material to be replicated is dried down on to a 'Formvar'-coated grid. This is coated with carbon from a source normal to the grid surface and the material removed. The source of carbon consists of two pointed carbons, spring-loaded and touching at the points. A heavy current is then passed across and a spot temperature of 2,000° C. is reached ; the carbon boils and a thin coating of structureless carbon is deposited on the grid. The 'Formvar' and material are then removed by their respective solvents (Fig. 3).

This technique has been applied in various fields and a resolution of 7 A. has been obtained.

Freeze Drying

The most serious source of structural deformation in biological specimens is the force of surface tension, and attempts have been made to adapt the old-established technique of freeze drying to electron microscopy. Two methods are current, one devised by Anderson[13] and the other by Williams[14].

Anderson's technique avoids surface tension forces by drying out in liquid carbon dioxide. The specimen is fixed in osmic acid vapour, dehydrated and finally obtained in a suspension with amyl acetate. The amyl acetate is washed out with liquid carbon dioxide under 30° C. The temperature is raised through the critical point of carbon dioxide (31° C.) and pressure released. This method suffers from the fact that changes in the specimen have been brought about by the introduction of solvents.

Williams's method is more suited for general work. A suspension of the liquid is sprayed on to a carbon-coated copper disk held at the temperature of liquid nitrogen. The disk is put in a vacuum, the temperature raised to −50° C., and the ice allowed to sublime. The carbon film is removed and placed on specimen grids ready for examination.

By the application of these modern techniques to the electron microscopy of viruses, it is now possible to obtain information on the following aspects: (1) size and shape of virus particles; (2) topography of virus particles; (3) surface detail; (4) internal structure; (5) methods of replication; (6) behaviour of viruses in the cell; (7) virus crystals; (8) latent viruses.

Size and Shape

Since little internal structure is visible in whole virus particles, most of the information on their size and shape has been obtained from shadowed specimens. Variations in size and shape are considerable; as we have already seen, some of the plant viruses are rod-shaped, that of tobacco mosaic virus measures 15 mμ × 300 mμ. Other rod-shaped plant viruses include potato viruses *X* and *Y* and a number of soil-borne viruses, some of which are latent in their plant hosts.

Many plant viruses are spherical or nearly spherical, and are very small; examples are the viruses of tomato bushy stunt, Southern bean mosaic, turnip yellow mosaic, tobacco ringspot and squash mosaic, all of which range in size from 30 to 27 mμ. These very small viruses are extremely uniform in size and shape and so are easily obtained in crystalline form. While the majority of the viruses affecting animals and the higher plants are either rod-shaped or nearly spherical, a number of the bacterial viruses are tadpole- or sperm-shaped with a 'head' and a 'tail'.

Air-dried preparations of virus particles in the electron microscope are apt to show distortion and appear smaller than they actually are. Accurate estimation of size, therefore, can only be made on frozen-dried specimens.

Topography of Virus Particles

It was suggested by Crick and Watson[15] that all small viruses are built up on a framework of identical protein sub-units packed together in a regular manner. They showed that three types of symmetry are possible for spherical viruses, namely, tetrahedral, octahedral and icosahedral.

Although many of the smaller viruses present a polyhedral appearance, it requires a combination of the freeze-drying and double-shadowing techniques to give the three-dimensional shape of the particle. A good example of this is provided by the *Tipula* iridescent virus, which even in air-dried specimens presents an almost perfect hexagon or pentagon. Although this virus is rather large, it exhibits such extreme uniformity of size that it easily crystallizes.

It has been shown by Williams and Smith[16] that the particle of this virus is an icosahedron with twenty sides. A cardboard model of an icosahedron was made and shadowed by two light-sources separated 60° in azimuth and orientated so that an apex of the hexagonal contour points directly towards each light source. Under these conditions two shadows are thrown: one has five sides and is blunt-ended and the other has four sides and is sharp-ended. When a frozen-dried particle of *Tipula* iridescent virus is treated similarly, two shadows identical with those thrown by the model are produced. By means of this shadow-analysis, it is proved that the *Tipula* iridescent virus particle is an icosahedron.

Surface Detail

Until recently the amount of external structure of virus particles which could be seen on the electron microscope was somewhat disappointing. It was not possible, for example, to make out the helical structure of the tobacco mosaic virus rod as revealed by X-ray studies. The new staining methods, however, especially negative staining with phosphotungstic acid[17], have given much improved results. By this means the arrangement of the protein sub-units of the virus particle can be visualized directly on the microscope.

Particles of adenovirus, type 5, have been examined in this way. At high magnification the particle has a roughly hexagonal outline and is clearly facetted, each facet being an equilateral triangle with a side consisting of six sub-units. The presence of triangular facets immediately excludes a dodecahedral form and suggests that the particle is an icosahedron. A model of an icosahedron with a side of six sub-units was built from table-tennis balls, and the arrangements of the sub-units in the virus particle and the model are identical. Herpes virus shows a similar sub-unit structure, but the sub-units appear to be hollow and ring-shaped[18].

The same technique has been applied to one of the bacterial viruses, φ*X*174, which apparently has a nearly spherical shape without the 'head' and 'tail' of the *T*-even 'phages[19]. The micrographs of this 'phage suggest that it contains a shell of twelve 'knobs' arranged regularly as on the faces of a regular dodecahedron. This is based on the observation of one apical and five surrounding peripheral knobs with the suggestion of a second underlying tier similarly arranged.

It has been suggested by Klug, Finch and Franklin[20] from X-ray data that the particle of turnip yellow mosaic virus is a snub dodecahedron made up from sixty spherical sub-units. Electron micrographs of this very small plant virus by Brenner and Horne using negative phosphotungstic acid staining show the presence of a number of sub-units.

A characteristic of the insect viruses is the presence of membranes surrounding the virus itself and the various ancillary structures associated with them.

In the early stages of infection with one insect virus, the *Tipula* iridescent virus, there occur many empty shells, the significance of which is discussed later. By means of phosphotungstic acid staining these shells appear to consist of a double membrane, two concentric hexagons. In addition, by negative phosphotungstic acid staining, protein sub-units on the surface of the full or apparently mature virus particles become visible.

Internal Structure

Improvements in the technique of cutting ultra-thin sections not only allow sections to be cut of the virus particle itself but also of serial sections through one particle. This obviously is one way of examining the internal structure of the virus, but the difficulty here is that the electron microscope cannot differentiate between the chemical constituents of the virus. Sections do, however, reveal differences in structure and quantities of contents and, as we shall see, show up the empty virus particles.

Another method is to treat the virus particles with enzymes which dissolve away the protein covering and leave behind the nucleoprotein.

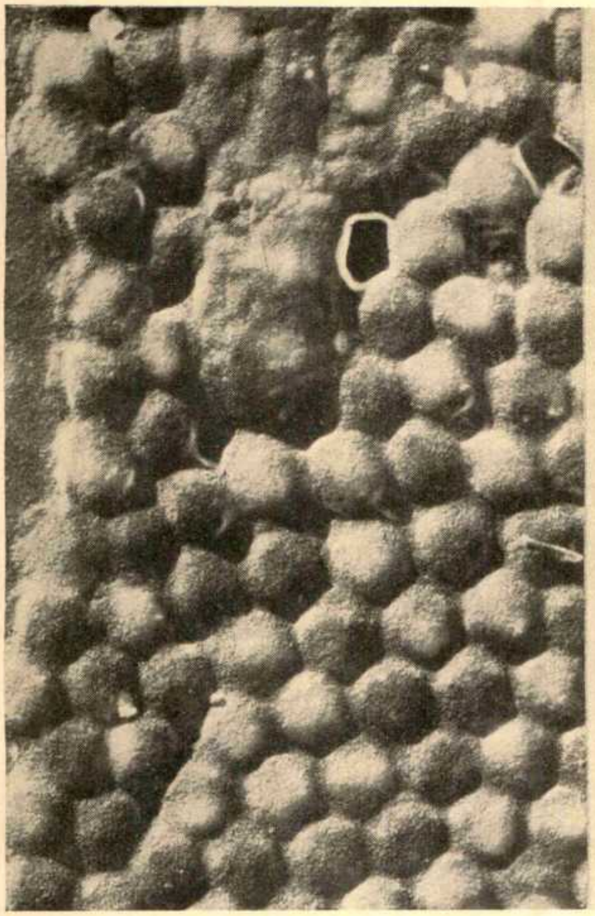

Fig. 3

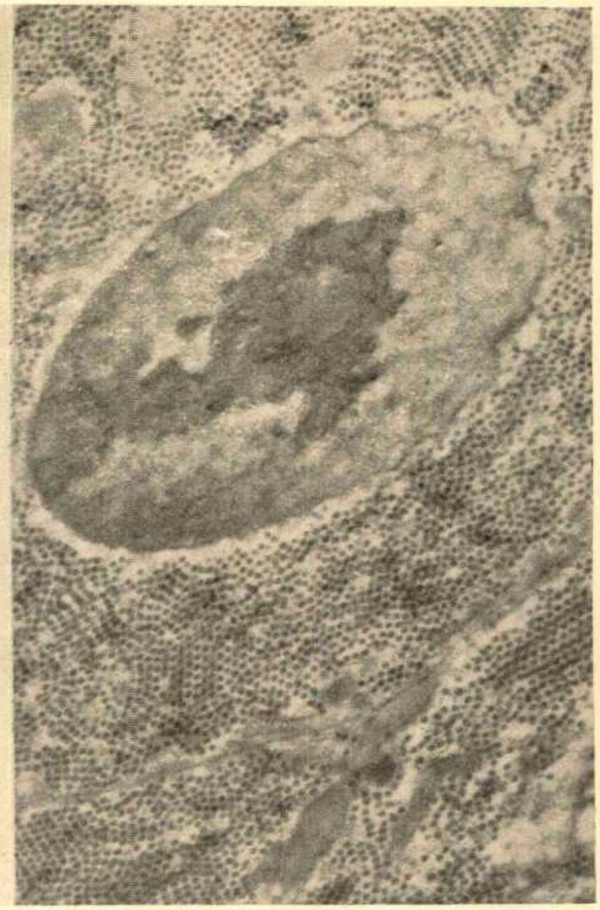

Fig. 4

Fig. 3. Carbon replica of an air-dried microcrystal of the *Tipula* iridescent virus. × 70,000

Fig. 4. Ultra-thin section of fat-body from a larva of *Tipula paludosa* infected with the iridescent virus; note how the virus avoids the nucleus and how the particles are orientated in regular array. × 10,000

Electron micrographs Figs. 1–4 by G. J. Hills

For studying the internal structure of virus particles by ultra-thin sectioning it is, of course, better to choose the larger viruses, although this technique, using a diamond knife, has been applied to tobacco mosaic virus[21].

Ultra-thin sections of vaccinia and fowl-pox viruses reveal a limiting membrane, a dense eccentrically placed body and a finely granular matrix. Sections of these viruses at a later stage seem to reveal developmental changes in which an elongated body surrounded by dense material can be seen[22].

Thin sections of the *Tipula* iridescent virus reveal a variety of different forms ranging from apparently empty shells to the mature virus with its two concentric hexagons.

The rickettsiæ, which strictly speaking should not be regarded as true viruses, are very suitable for this type of study. Thin sections of purified *Rickettsia burnetii* reveal a limiting membrane within which lie a granular region and a dense central body. The configuration of the central body suggests that it may consist of an elongated and irregularly twisted strand[23].

The method of digesting the protein covering and observing the residue by means of the electron microscope has only been applied to the larger viruses. When the influenza virus was treated on the microscope grid with various enzymes, the nucleoprotein component was left behind in the form of an irregular ring built of long threads. A similar result has been obtained with the virus of Newcastle disease of fowls, and when stained with phosphotungstic acid the ring showed a number of dark lines, possibly representing the tracks along the protein to which the long nucleic acid molecule is bound[24].

Methods of Replication

The way in which viruses reproduce themselves has always been a subject of great interest and it is only recently that definite information on this subject has been obtained. Although we know that they do not grow and divide but replicate themselves from their genetic material, it is probable that the method of replication is not the same for all viruses. The most precise information has been obtained on the multiplication of the *T*-even 'phages, and their method of replication is closely bound up with their possession of a 'head' and 'tail'. The 'phage particle attaches itself to the bacterial cell wall which it penetrates and the deoxyribonucleic acid contents of the head pass down into the bacterium[25]. What happens next has been well shown by Kellenberger *et al.*[11]. They used a 1 per cent osmic acid fixative dissolved in acetate veronal buffer, stained their preparations with uranyl acetate and embedded for sectioning in 'Vestopal *W*'. In an infection of *Escherichia coli* by T_2 'phage, the breakdown of the bacterial nucleus is accompanied by the formation of marginal vacuoles containing deoxyribonucleic acid, from which the pool of 'phage deoxyribonucleic acid develops some minutes later. The phage deoxyribonucleic acid starts to increase 6–7 min. after infection. Then, about 9 min. after infection, the protein precursors, immature 'phages and finally, at 13 min., complete 'phage particles appear in the infected cell.

Ultra-thin sections of the fat-body of a larva of *Tipula paludosa* infected with the iridescent virus in an early stage of the disease reveal few virus particles but large numbers of empty or partially empty shells. Some of these membranes contain a few threads, others a central body which varies in size from a small granule to a darkly staining mass filling the membrane. It has been suggested that these empty membranes may represent a stage in the development of the virus ; the assumption being that the membranes form first and the nucleoprotein is afterwards introduced into the empty shell. In sections fixed in formalin it is possible to see the membranes apparently being formed from the substrate.

Behaviour of Viruses in the Cell

The technique of ultra-thin sectioning has allowed the virus to be observed *in situ* in the cell, and a good deal of information on its behaviour has been obtained. Perhaps the least successful in this direction have been the studies of viruses in plant cells. This is partly due to the difficulty in distinguishing between the virus and the normal cell constituents and is particularly true of the very small plant viruses. It occasionally happens, however, that the virus may be concentrated in a small area and then becomes easily visible. In ultra-thin sections of *Datura stramonium* infected with tomato bushy stunt virus, micro-crystals of the virus may sometimes be seen.

It is much easier to observe the animal viruses in the cells, particularly when grown in tissue culture. Certain insect viruses, too, are very suitable for observation in thin sections of infected tissue.

It was shown by Morgan *et al.*[26], by means of sections of chorioallantoic membrane cells infected with herpes virus, that the virus differs slightly according to whether it is in the cytoplasm or the nucleus of the cell. The intracellular cytoplasmic particles consist of a dense central body, surrounded by a double membrane. In the nucleus, however, the particles contained the same central body but only one membrane.

The rate of development of herpes virus has been followed in cultures of HeLa cells. Samples of cells exposed to heavy infection were sectioned and examined for virus at successive time intervals after infection. No increase in infective virus was found in the cultures at 9 hr., but at 12 hr. new virus appeared in the cell fraction and particles were found in the nuclei of two of twenty-five cells. At 26 hr. after infection and later, large numbers of virus particles were present in both nucleus and cytoplasm and on the cell surface[27].

Sections of fat-body from the larvæ of the fly *Tipula paludosa* infected with the iridescent virus reveal enormous quantities of virus in the cytoplasm of the cell but never in the nucleus. The concentration of the virus is such that it forms liquid crystals in the living insect, giving rise to a characteristic blue or violet iridescence (Fig. 4).

Another virus found attacking the same fly larva causes a polyhedral disease, so-called because of the polyhedral bodies which develop in the tissues and which contain the virus. They are protein crystals, not virus crystals. In this disease the virus develops in the nucleus of the blood cells and not, like the foregoing, in the cytoplasm. The virus particles are rod-shaped and are enclosed in a membrane. After formation in the nucleus, the virus rods become occluded in the polyhedra, which lie on the outside of the nuclear membrane (Fig. 1).

Virus Crystals

Because of their small size and great uniformity, a number of viruses have been obtained in crystalline form. This is particularly true of the plant viruses, and examples are those of tomato bushy stunt, tobacco necrosis, turnip yellow mosaic, Southern bean mosaic and others. The crystals of tobacco necrosis virus are very suitable for electron microscopy because of their flat shape and resistance to the electron beam. Replicas of these crystals show clearly the orientation of the virus particles in the crystalline lattice.

After the crystallization of the plant viruses, the production of some animal viruses in the crystalline state passed without much comment. The first of these viruses to be crystallized was that of poliomyelitis and the next the *Tipula* iridescent virus. Crystalline inclusions of herpes virus and adenovirus have also been observed[22]. The crystal structure of *Tipula* iridescent virus is face-centred cubic with the particles held at a distance apart by long-range forces. These crystals show Bragg reflexions of visible light and are responsible for the blue or violet colour of infected larvæ.

We have seen already that many of the small viruses are polyhedral in shape. Electron micrographs of replicas of a plane surface cut through the interior of a single crystal of poliomyelitis virus show this very well[28].

Latent Viruses

Latent infection is an interesting phenomenon which occurs commonly. It is frequently met with in plants and even more frequently in insects, while so many new viruses have been discovered in the excretions of man and monkey that they are known as 'viruses in search of a disease'.

On the whole, attempts to visualize latent viruses *in situ* on the electron microscope have been disappointing, though rod-shaped particles have been observed in healthy plants.

It does not seem possible to stimulate a truly latent plant virus into activity ; it is necessary to inoculate it into another host in order to produce a disease. This, however, does not apply to latent virus infection in insects, which can be 'triggered off' in a variety of ways. This phenomenon has been well demonstrated during cross-inoculation studies. It frequently happens that larvæ, which have been inoculated with a foreign virus, die of a virus disease. Examination, however, may show that the virus which killed the larva was not the one injected but a latent infection stimulated by the foreign virus. This phenomenon has interesting repercussions, because it may be used to obtain new viruses from insect orders in which no virus disease has been recorded For example, until recently no virus had ever been found in the order Neuroptera, but now two or more have been discovered in the carnivorous larvæ of *Chrysopa* and *Hemerobius*, better known as 'lacewing flies' or 'golden eyes' Their predacious larvæ live mainly on aphids but can be induced to feed on pieces of caterpillar infected with a polyhedral virus disease A fairly high percentage of the larvæ that do this die about ten days later from a very similar polyhedral disease (Sidor, C, unpublished work, see also ref 29)

It has long been an axiom that insect viruses were very specific and that transmission to other species did not occur or only rarely did so Experiments to test the truth of this were difficult, owing to the complication of latent infection referred to above However, this difficulty has been overcome with the discovery of the *Tipula* iridescent virus; this gives the opportunity of repeating the cross-transmission studies in a way that avoids the possibility of confusing latency with transmission It is unique in the sense that from an infected insect the virus can be isolated in the form of a brilliant iridescent pellet No other known insect virus has this property, and so *Tipula* iridescent virus can be used as a marker and identified with certainty With this virus it has been possible not only to infect a number of very different fly larvæ but also to transmit the virus back and forth between three different orders, the Diptera, Lepidoptera and Coleoptera[30]

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COMPARATIVE STUDIES OF ULTRASTRUCTURE IN BIOLOGY

THE success with which the electron microscope has been used in biological research during the present decade was usefully brought to the attention of a wide variety of biologists by the Linnæan Society of London when it organized a one-day symposium entitled "Comparative Studies in Ultrastructure", held in the British Museum on April 24

Presenting his paper, "Microsomes and Ribonucleoprotein Particles", Dr G E Palade (Rockefeller Institute, New York) began by surveying the research which set the stage for one of the outstanding achievements of electron microscopy, the identification of certain small particles in the cytoplasm of cells of many different kinds as the sites at which one of the steps in protein synthesis is very probably carried out The advances in the techniques of specimen preparation which made this possible, and had also benefited the other investigations discussed in this symposium, were in several instances due to work carried out at the Rockefeller Institute

At the time when electron microscopy began to be applied to the problems of cell growth and the manufacture of secretory products by cells, it was believed that ribonucleic acid was intimately concerned It was also known that the sites of this substance in the cytoplasm were basophilic, and that microsomes (one of the cell components isolated by fractionation procedures) were rich in ribonucleic acid Dr Keith Porter and Dr Palade and their colleagues then discovered the submicroscopic 'endoplasmic reticulum' in the intact cell, identified it with the basophilic material seen in the light microscope and showed that the microsomes were derived from it Palade observed that the membranes of the reticulum often, but not always, carried numerous small dense particles, about 150 A in diameter Using electron optical and biochemical techniques in parallel, Palade and Siekevitz demonstrated that these small particles were rich in ribonucleic acid and that the basophilia of cytoplasm and the ribonucleic acid content of microsomes were due to these ribonucleoprotein particles and not to the membranes of the reticulum But not all the particles are attached to the membranes, many lie 'free' in the cytoplasm

Meanwhile, it had been shown by other workers that microsome preparations could incorporate labelled amino-acids into their proteins Palade and Siekevitz have recently studied the synthesis of chymotrypsinogen and trypsinogen and the turnover of ribonucleic acid in pancreatic cells Various cell fractions (microsome-attached ribonucleoprotein particles, 'free' ribonucleoprotein particles, 'soluble' ribonucleic acid, etc) have been separated and their radioactive isotope and enzyme contents measured The results clearly implicate the ribonucleoprotein particles in enzyme manufacture and suggest that their role may be to arrange activated amino-acids in specific sequences in the polypeptide chains of the proteins they are synthesizing.

The recent technical advances in the preparation of tissues for electron optical studies were admirably illustrated in a paper on "The Fine Structure of Vertebrate Neurons and Their Processes" by Dr. S. A. Palay (U.S. National Institutes of Health, Bethesda). He gave a detailed description of the neuron and brought out the subtle differences in structure between axons and dendrites on which depend the interpretation of the very complex pictures seen in electron micrographs of brain sections. Thus, dendrites contain large numbers of long tubules, about 200 A. in diameter, and clumps of Nissl substance, that is to say, endoplasmic reticulum bearing ribonucleoprotein particles. Axons, on the other hand, are distinguished by large numbers of neurofilaments, about 100 A. in diameter; Nissl substance is absent. These neurofilaments have approximately the same dimensions as the fibrous-protein molecules isolated by Maxwell and his colleagues from the axoplasm of the giant nerve-fibres of squid. Dr. Palay attributed the positive birefringence of axoplasm to the neurofilaments because he found that this optical property is enhanced by lipid extraction.

Among other features discussed in this paper was the structure of synapses, characterized by the increased density of the apposed cell membranes and by the presence of numerous small granules on the presynaptic side, together with mitochondria and elements of the endoplasmic reticulum.

During the past few years evidence has been brought together from several sources to show that cross-striated myofibrils are made up of a longitudinal series of alternating arrays of myosin and actin filaments, giving rise to the *A* and *I* bands; furthermore, that these arrays partly overlap in the *A* bands, and slide into or out of each other as the muscle changes its length, the protein filaments themselves staying at constant length. This evidence has led to the sliding filament hypothesis of muscular contraction, which is based on biochemical and physiological as well as structural information. The hypothesis has received strong support from the results of electron microscopy, which have revealed the spatial relationships of the two kinds of filaments and shown the existence of cross-bridges between them. This work (by H. E. Huxley) and information obtained by Hanson and Huxley by different methods (which confirm and extend the interpretation of the electron micrographs) were reviewed in a paper entitled "Comparative Studies in the Contractile Structures of Striated and Smooth Muscles", by J. Hanson, H. E. Huxley and J. Lowy (Medical Research Council, King's College and University College, London).

The sliding filament hypothesis was based on studies of vertebrate skeletal muscles, and until recently too little was known about smooth muscles, or about any other contractile system, for one to be able to say whether or not a sliding filament mechanism is a special property of striated muscles. But Hanson and Lowy have now found that in three different types of smooth muscles (the byssus retractors of the mussel *Mytilus*, the translucent part of the adductor of the oyster, and the funnel retractor and mantle muscles of the squid) the contractile apparatus consists of two kinds of filaments linked by bridges which resemble those seen in electron micrographs of cross-striated muscles. In all these smooth muscles one kind of filament is about 50 A. in diameter, like the actin filaments of striated muscles. The other kind of filament is thicker, the diameter varying from one type of muscle to another. In the case of the *Mytilus* byssus retractors, a comparison of extended and contracted muscles, cut transversely, has shown that neither the diameters of the thicker filaments nor their numbers (in unit area) change as a result of length changes in the muscle. These findings indicate that the thicker filaments are discontinuous along the fibre and do *not* contract. Such electron optical evidence (together with certain results from X-ray diffraction and light microscopy) strongly suggests that these smooth molluscan muscles contract by a sliding filament mechanism. (However, the smooth muscles of vertebrates, of which Mrs. C. Schoenberg showed some electron micrographs in the discussion following this paper, apparently possess only one kind of filament, about 50 A. in diameter, and no bridges have yet been seen.)

The rest of the paper dealt with work done by Hanson and Lowy on the structure of several molluscan muscles which show various degrees of tonicity, that is to say, the ability to maintain a steady high level of tension for prolonged periods of time. These comparative structural investigations have been carried out in parallel with experimental studies on the mechanical properties of the muscles.

It has been found that the more tonic a muscle is, the longer tension persists after stimulation has ended and the active state has decayed to zero. Thus, in the tonic anterior byssus retractor of *Mytilus*, the decay of tension can be two orders of magnitude slower than that of the active state, whereas in non-tonic muscles like the frog sartorius, or the smooth funnel retractor of *Octopus*, the time scales of the two processes are of the same order of magnitude.

Electron optical studies show that muscles such as the funnel retractors of cephalopods contain well-differentiated myofibrils and sarcoplasmic reticulum, and that their filaments are regularly packed and of relatively small diameter (about 100 A. and 50 A.). In these features such muscles resemble vertebrate skeletal muscles, the chief differences being the absence of *Z* lines and of any alignment of the two kinds of filaments into transverse arrays. At the other extreme, in a specialized tonic muscle like the anterior byssus retractor of *Mytilus*, the filaments are not grouped into fibrils, but are irregularly packed, and they vary greatly in diameter, the thicker ones (that is to say, those which are not of the 50 A. kind) ranging from about 150 A. up to more than 1000 A. In addition, such tonic muscles are distinguished by the fine structure of their thicker filaments. This structure has been found to be due to the presence of large amounts of tropomyosin. The problem now is to show if, and how, tropomyosin is involved in the mechanism responsible for the tonic specialization of smooth muscles, which contract similarly to non-tonic muscles by a sliding filament mechanism.

One of the classical problems of muscle physiology, namely, the means by which the excitatory stimulus reaches the contractile elements inside a muscle fibre, has been brought a step nearer solution by the application of electron microscopy. Several earlier light microscopists described transversely-orientated structures (as distinct from the longitudinal myofibrils and their bands) in striated muscle, and already in 1881 Retzius had suggested that these structures were involved in excitation. The greater resolution of the electron microscope has made possible a more detailed study of these structures, which are now known as the 'sarcoplasmic reticulum' The recent work of A F Huxley (Cambridge) and his colleagues goes a long way towards showing that this reticulum, or probably one particular part of it, is somehow concerned in conducting the excitatory stimulus

In a paper entitled "Comparative Study of the Activation of Contraction in Muscle", Huxley described how isolated muscle fibres were viewed in an interference microscope or in a polarizing microscope, while the potential difference across the surface membrane was changed over a very small area by passing current through a micropipette in contact with the membrane It was found that excitation was conducted transversely (inwards into the fibre) only when current was applied at the levels of the *Z* lines in frog fibres, and near the *A* *I* boundaries in crab and lizard fibres But responses were not obtained everywhere as the micropipette was moved around the perimeter of the fibre at these levels, instead it was found that the sensitivity was limited to definite small areas Stimulation at these places resulted in local contractions which extended into the fibre for a distance several times greater than the length of the sarcomere, but did not spread longitudinally into adjacent sarcomeres Effective stimulation in the frog fibre always resulted in an equal shortening of both halves of the *I* band, the *Z* line remaining central, but in lizard or crab fibres it was possible to cause the *Z* line to move towards one *A* band, its distance from the other *A* band usually increasing as this half of the *I* band was actually stretched All these results were elegantly and convincingly demonstrated in ciné films

The location of the sensitive regions near the *A* *I* boundary in crab and lizard fibres, and the finding that only one half of the sarcomere shortens, suggest that the *Z* line cannot be the structure concerned in conducting excitation Instead, it is probable that certain differentiated elements of the sarcoplasmic reticulum—the 'triads' first described by Porter and Palade—are involved, because as Huxley showed in electron micrographs, these 'triads' are located at the *Z* line level in frog fibres, and near the *A* *I* boundary in lizard fibres

As the title shows, the symposium was planned to emphasize the value of the comparative approach to biological problems The papers on muscle illustrated two successful applications of this the identification of structures concerned with a given function (for example, transmission of stimulation into a muscle fibre) by comparing systems where these functions are differently located, and the recognition of fundamental properties (for example, the structural features which are common to all kinds of contractile systems) by comparing muscles specialized in different ways Similarly, a comparison of different kinds of cells, particularly mammalian, which vary in the intensity and distribution of cytoplasmic basophilia, helped to locate ribonucleic acid at the sub-microscopic level Also the importance of getting away from stock laboratory animals and looking for other more suitable experimental material was brought out by the notable success of Dr Palay in preparing the central nervous system for examination in the electron microscope he chose to work on goldfish However, the only papers which dealt with invertebrate animals were those on muscles, and it was disappointing that in none of the papers was there any mention of plant cells

J Lowy

NEWS and VIEWS

Thermo-Nuclear Physics at Sydney

Prof C N Watson-Munro, O B E

Mr C N Watson-Munro has been appointed, as from January 1, 1960, to the chair of physics in the field of thermo-nuclear physics in the School of Physics, at the University of Sydney The chair normally will be vacant on the retirement of Prof V A Bailey at the end of 1960, but provision has been made for the earlier filling of the chair Mr Watson-Munro was born at Dunedin, New Zealand, in 1915 He graduated at Victoria University College, Wellington, with first-class honours, winning the Sir George Grey scholarship and later a Jacob Joseph scholarship for postgraduate research In 1935 he joined the Department of Scientific and Industrial Research, New Zealand, where he carried out original work on problems of seismology and geophysics at the Dominion Physical Laboratory In 1939 he joined a team engaged on radar development of which he became the leader In 1941 he went to the United States and worked on radar research at the Massachusetts Institute of Technology before establishing the first New Zealand Scientific Liaison Office in Washington in 1942 Later that year he returned to New Zealand to become the director of the New Zealand Radar Development Laboratory Early in 1944 he was specially invited to join the Atomic Energy Research Project at the Chalk River Laboratories in Canada under the direction of Sir John Cockcroft He was largely responsible for the design and operation of the first power heavy-water pile to be built Transferring in 1946 to the Atomic Energy Research Establishment, Harwell, he was, as principal scientific officer, in charge of the team responsible for the design, construction, and operation of Britain's first atomic pile, *Gleep*, a low-power graphite pile that was constructed in fifteen months and has proved very successful He returned to New Zealand in 1948 to take charge of the Department of Scientific and Industrial Research Accepting the chair of physics at Victoria University, Wellington, in 1951, Prof Watson-Munro became dean of the science faculty of that University in 1954 In 1955 he was appointed chief scientist of the Australian Atomic Energy Commission responsible for the Lucas Heights Research Establishment which was constructed under his supervision

Theoretical Physics at Sydney

Prof S T Butler

Dr S T Butler has been appointed, as from November 2, 1959, to the chair of physics in the field of theoretical physics in the School of Physics, at the University of Sydney This is a newly created chair

Dr Butler first studied at the University of Adelaide and graduated (B Sc) in 1945 with credits in all subjects (physics, pure mathematics and applied mathematics) He obtained his first-class honours degree at Adelaide in 1946, and his M Sc in 1947 This latter was for theoretical work, in collaboration with the Physiology Department at the University of Adelaide, and involved an analysis of the transient responses of electronic equipment being employed in physiological and biological research In 1948 Dr Butler obtained an Australian National University scholarship, and proceeded to the Department of Mathematical Physics at the University of Birmingham, England, to work under the supervision of Prof R E Peierls He remained there until September 1951, obtaining his Ph D from the University of Birmingham in June 1951 In September 1951, Dr Butler took up a position in the Laboratory of Nuclear Studies at Cornell University, where he remained for two years He then returned to Australia first to spend ten months at the Australian National University at Canberra, Australia, and then to take a readership at the University of Sydney Since leaving Birmingham in 1951, Dr Butler has made research contributions in several fields, including the low-temperature problems of liquid helium and superconductivity, and in the field of meson and strange particle physics Most of his work, however, has been in the field of nuclear reactions, not only furthering his original work on stripping reactions, but also as one of the originators of the general field of direct nuclear reactions

Scientific Adviser to the U K High Commissioner in India

Dr H R Ambler, O B E

Dr H R Ambler has been appointed to the newly created post of scientific adviser to the U K High Commissioner in New Delhi In addition to advising the High Commissioner on scientific matters, he will be responsible for furthering the exchange of information between British and Indian scientists Dr Ambler, who is fifty-eight, will hold the rank of senior principal scientific officer in the Department of Scientific and Industrial Research He joined the Government service shortly after he graduated with first-class honours in chemistry at the University of London in 1920 Since then he has held a variety of posts at home and abroad, including seven years in India At present, Dr Ambler is assistant director of the Chemical Inspectorate of the Ministry of Supply at Woolwich Dr Ambler, whose appointment is for three years in the first instance, is taking up his new duties at the end of the year.

Explosives Research and Development at the Ministry of Aviation

Dr. C M Johnson, C B E

The Ministry of Aviation announces that Dr C M Johnson has been appointed director of the Explosives Research and Development Establishment at Waltham Abbey Dr Johnson was born in 1904 and gained his Ph.D. at the University of London in 1927 For the next eleven years he was a lecturer in chemistry at the University of California and the University of Bristol In 1938 he joined the Shell Refining and Marketing Co as research manager, moving in 1948 to the Explosives Research and Development Establishment Since 1954 he has been director of the Materials and Explosives Research and Development Branch

Deputy Director of Air Armament Research :

Mr W H Hill

Mr W H Hill has been appointed deputy director of air armament research He was born in 1915 at Warwick, and gained his degree at the University of Cambridge During 1937–41 he was an assistant lecturer in applied mathematics at the University College of the South West, Exeter In 1941 he joined the Royal Electrical and Mechanical Engineers, and was posted to work with the Ministry of Supply on radar and signals research From 1946 until 1951 he worked at the Army Operational Research Group, where he became general scientific co-ordinator In 1951 he joined the Department of the Scientific Advisor to the Army Council In 1952 he was appointed to the Royal Aircraft Establishment, working on guided weapons, and in 1954 he transferred to the Armament Research and Development Establishment as superintendent of the Weapons Assessment Department

History of Medicine and Pharmacy

A Faculty of the History of Medicine and Pharmacy has been founded under the auspices of the Worshipful Society of Apothecaries of London (which received its Charter from King James I in 1617) Its aim is to foster and extend more general interest in medical history, and to attract the co-operation of general historians, so that work in this field may be co-ordinated with wider historical studies The Society will provide in its ancient hall a central meeting point for historians, and medical and pharmaceutical historical societies In addition to the Gideon de Laune Oration, which will next be delivered by Sir John Charles in April 1960, it has an endowment for two additional lectures which may be delivered in London or elsewhere A research fellowship, generously endowed by the Wellcome Trustees, is held at present by Mr R S Roberts, a professional historian, who is working upon the early organization of the drug trade from the seventeenth century It is proposed to hold occasional symposia, discussions, congresses, and joint meetings with other bodies , invitations to visit sites of medical historical interest have already been received Announcements and reports of meetings will appear in the official organ of the Faculty, *Medical History*, which is published quarterly Ordinary membership of the Faculty is by election Applications for affiliation from student historical, medical or pharmaceutical societies or similar bodies, which should nominate a representative, can also be accepted The inaugural lecture will be given in the Hall of the Society on December 2 by Canon Charles E Raven, on ' Medicine—Mother of the Sciences" Further information can be obtained from the honorary secretary, Dr F N L Poynter, Wellcome Historical Medical Library, Euston Road, London, N W 1

Distribution of British Books and Films Overseas

In reply to a question in the House of Commons on November 9, the Chancellor of the Duchy of Lancaster, Dr Charles Hill, said that negotiations had begun with several countries with the aim of agreeing upon schemes broadly on the lines of the former British book export schemes Mr A L P Norrington had accepted the chairmanship of the Advisory Committee on the Selection of Low-Priced Books for Overseas, and the necessary administrative arrangements were being made so that negotiations on contracts could begin as soon as titles had been selected A Publishing Trade Consultative Panel had been set up after consultation with the trade organizations concerned The British Council was steadily expanding its own library services and co-operating with Colonial Governments in improving their services and there had been consultation with trade organizations in the periodical field on measures to assist circulation of newspapers and periodicals in some of the more difficult markets overseas Consultation was also taking place with the publishing trade in Great Britain and other countries with the view of encouraging more effective wholesaling and retailing of books in the African countries in particular Answering a further question, about documentary films, Dr Hill said that in 1958–59 the Central Office of Information commissioned twenty-eight documentary films and acquired 118, all for overseas distribution, and in 1959–60 it was expected that about 120 would be acquired More than a hundred British films had been entered in 1959 for showing at international festivals and twenty-one awards or special mentions had been gained

National Lending Library for Science and Technology Consultative Committee

A consultative Committee has been appointed to advise the Department of Scientific and Industrial Research on the services of the National Lending Library for Science and Technology Literature is now being collected for the Library by the Lending Library Unit of the Department at 20 Chester Terrace, Regent's Park, London, N W 1 The National Lending Library for Science and Technology will be located near Boston Spa, Yorkshire, and its transfer will take place in the first half of 1961 Its collection of scientific literature, which will become the largest in the United Kingdom, will be available to any organizations through loan and photocopying services

The Committee is as follows · Sir Lindor Brown, biological secretary of the Royal Society (*chairman*), Prof J D Bernal, professor of physics, Birkbeck College, London, Mr D I Colley, librarian, Manchester Public Library, Dr B M Crowther, editor of *Science Abstracts*, Mr G. H Davison, secretary of the United Steel Companies, Ltd, Research Department, Dr R E Fairbairn, head of the Library Department, I C I Dyestuffs Division, and chairman of the Council of Aslib, Mr R M Fishenden, United Kingdom Atomic Energy Research Establishment, Harwell, Prof G Gee, Sir Samuel Hall professor of chemistry, University of Manchester, Mr C W Hanson, research officer, Aslib; Mr L J H Haylor, Ministry of Supply, Mr K W Humphreys, librarian, University of Birmingham, and secretary of the Standing Conference of National and University Libraries; Mr D D Morgan, information manager, P E R A, Prof W J T Morgan, Lister Institute of Preventive Medicine, London, Mr H T Pledge, keeper, Science Museum; Dr M R Pollock, Medical Research Council, Mr A C Townsend, library of the British Museum (Natural History) The secretary of the Committee is Miss R M Bunn

Dounreay Fast Breeder Reactor Critical

The Fast Breeder Reactor at Dounreay went critical on November 14 The reactor will go through a period of low-power operation for some months This may be followed by a shut-down for any modifications found necessary, and the reactor will then be worked up to power in stages Construction work on this reactor started in May 1955 and it was scheduled to start operating last year Because of the redeployment of staff due to the Windscale pile incident and to certain design modifications, start-up has been delayed The reactor consists of a central core which is a hexagonal prism approximately 21 in high and 21 in across the flats This is made up of about 360 enriched uranium rods in niobium cans, and is surrounded by a 'blanket' of 2,000 rods of natural uranium which under irradiation produces plutonium Plutonium can be used in the core to produce more heat and more plutonium, and experiments have shown that the amount of fissile material produced in the core and the blanket during operation will exceed the amount burned up in the core, and the reactor is thus a breeder In this type of reactor the neutrons are not deliberately slowed down as in a thermal reactor, that is, no 'moderator' is used and the neutrons are said to be 'fast' Heat is removed from the core and blanket by a liquid sodium–potassium alloy, which is circulated by electromagnetic pumps through the vessel and through heat exchangers The reactor with its primary heat exchanger circuits is installed in a concrete vault within the 135-ft diameter steel sphere which dominates the Dounreay site In the early stages the Dounreay reactor will be operated to provide information on the physics and control characteristics of this type of system, and this will be followed by a stage of intensive development and testing of different types of fuel elements

South African Council for Scientific and Industrial Research

The thirteenth annual report of the South African Council for Scientific and Industrial Research covers the year ended March 31, 1958, and includes lists of research bursaries and assistantships awarded during the year as well as a list of publications (Pp xvii + 226 + xix–lix Pretoria South African Council for Scientific and Industrial Research, 1958) Concern is expressed as to the shortage of scientists and particularly at the loss overseas of promising South African scientists Much interest is being taken in the work on the demineralization of water by electrodialysis, and the plant designed by the Council and being erected at Welkom has a capacity of 2 5 million gallons a day River surveys involved a comprehensive programme of chemical, biological, bacteriological tests and flow data, as well as laboratory studies on the chemical and biological reactions in water and river mud A Wine Research Unit was established at Stellenbosch, where it is hoped that investigations of the causes of biotic turbidity will offer a solution of a serious problem in South African wines Investigations on the chemical mechanism of carcinogenesis continued Initial difficulties with the cyclotron at the National Physical Laboratory were overcome during the year and improvements in several of the basic components increased the stability of operation The isotope separator was assembled in December 1957, and the electro-mechanical recording systems in South African Courts established by the Acoustics Division were further extended Under a recently established Foundry Sands fellowship the properties of available sands are being studied and their suitability for casting determined At the National Mechanical Engineering Research Institute work was carried out on the phenomenon of rock-bursts with a view of devising methods for their prevention or at least of decreasing their incidence and severity. The Institute is also studying erosion, the silting of rivers and harbours, coal-burning gas turbines and solar operated refrigeration systems.

In telecommunications a radio tracking system was improvised which enabled the orbit of the first Russian Earth satellite to be determined roughly within a few days and an accurate determination of the velocity of radio waves was made by means of extensive measurements at the Ridgeway base and surrounding triangulation to provide a value which can be used confidently in work with 'tellurometers'. Work was carried out on the shear strength of non-saturated soils under different moisture conditions and the stresses set up in various layers of road foundations by compaction operations or surface loads were closely observed. Experimental studies on the relations between malnutrition and the mental development of young children showed that 38 per cent of a group of Bantu children suffering from kwashiorkor had abnormal electroencephalograms compared with only 3 per cent of normal children, and another study showed that rats bred from protein-deficient mothers and themselves reared on protein-deficient diets were inferior in learning ability to those bred and fed normally. In medical research particular attention is being given to the relation between diet and diseases of the arteries.

Waterways and Ionizing Radiations

CIRCULAR No. 57/59 from the Ministry of Housing and Local Government to local authorities, joint water boards, joint sewage boards, river boards, statutory water companies in England and Wales tells them from which departments of the Government they should seek advice when in doubt about local problems concerning hazards from ionizing radiations. As a potted "Inquire Within on Everything" in this field it is extremely informative and helpful. As an explanation of the scientific problems involved it is slipshod, since the construction of the sentences is tortuous, 'radioactivity' is confused with 'radiation' and there is at least one mis-statement attributed to the Medical Research Council on the contribution by diagnostic X-rays to the dose of radiation received by the general population.

Hatfield Memorial Lecture

ACADEMICIAN G. V. KURDJUMOV, director of the Department of Metallography and Metal Physics at the Central Research Institute for Ferrous Metallurgy, Moscow, has accepted an invitation from the Council of the University of Sheffield to deliver the twelfth Hatfield Memorial Lecture, in the Firth Hall of the University on November 25. His subject will be "The Phenomena occurring in Steels during Quenching and Tempering". The Hatfield Lectures, which are given annually in either London or Sheffield, were founded in memory of the late Dr. W. H. Hatfield, and are always devoted to a subject in which Dr. Hatfield was interested. The Hatfield Memorial Lecture Fund is administered by the University of Sheffield as trustees, and arrangements are in the hands of a Lecture Committee, composed of representatives of the University, the Royal Society and the Iron and Steel Institute. Academician Kurdjumov is also to lecture to the Iron and Steel Institute during the autumn general meeting in London. He will be speaking at the Hoare Memorial Hall, Church House, Great Smith Street, S.W.1, on December 2, and on this occasion his subject will be "Martensitic Transformations in Metals and Alloys".

International Federation of Automatic Control

FOLLOWING the first General Assembly in Chicago of the International Federation of Automatic Control, it is announced that the Executive Council now consists of the following members: *President*, A. M. Letov (U.S.S.R.); *Past President*, H. Chestnut (U.S.A.); *First Vice-President*, Ed. Gerecke (Switzerland); *Second Vice-President*, O. Benedikt (Hungary); *Treasurer*, M. Cuénod (Switzerland); *Ordinary Members*, J. G. Balchen (Norway), J. F. Coales (Great Britain), G. Evangelisti (Italy), K. Kaneshige (Japan), P. J. Nowacki (Poland), Z. Trnka (Czechoslovakia). D. P. Eckman (U.S.A.) will remain chairman of the Advisory Committee of which J. Loeb (France) was appointed vice-chairman.

The Vernon Prize

THE late Dr. H. M. Vernon made a bequest to the National Institute of Industrial Psychology expressing the wish that the Institute should award a prize every second year to the investigator who, being a British subject and under the age of forty-five years, has in the opinion of the council of the Institute done the most valuable research work in the service of industrial psychology or industrial physiology. The fourth award will be made in 1960; it will consist of approximately £40 in cash and a silver medal. Recommendations and direct applications must be received by February 29, 1960. Further information can be obtained from the Secretary, National Institute of Industrial Psychology, 14 Welbeck Street, London, W.1.

Royal Agricultural Society of England Research Medal

THE Royal Agricultural Society of England offers annually a Medal together with an award of 100 guineas for research work of outstanding merit carried out in the United Kingdom which has proved, or is likely to prove, of benefit to agriculture. Recommendations for this award can be made by the heads of university departments, research stations and institutes and other research organizations. No direct application by candidates will be considered. Recommendations for the next award must be submitted to the Secretary, Royal Agricultural Society of England, 35 Belgrave Square, London, S.W.1, not later than January 30, 1960, and from whom further information can be obtained.

Course on Digital Computers

THE British Council is arranging a course on digital computers in London during February 7–20 for industrial and research scientists from overseas. The course will concentrate on recent improvements in computer design and programming techniques, and will be closely linked with practical work in industry. Many firms have already offered to show computers being made or actually used for commercial and industrial purposes. Course members will also be able to discuss problems with workers on the job. The course will be directed by Dr. Andrew Booth, head of the Department of Numerical Automation at Birkbeck College. Visits have been arranged to see computing equipment at the National

Physical Laboratory (*Deuce* and *Ace*), Ferranti (*Pegasus* and *Sirius*), Elliot Brothers, Cambridge University Mathematical Laboratory (*Edsac II*), E M I. Electronics (*Emidec*), London University Computational Laboratory (*Mercury*) Creeds (project high-speed punching), Solatron (*Era*), Leo Computers and International Computers and Tabulators The fee for the course is £47 and accommodation will be in London hotels

Radioisotopes in Agricultural Research

A REGIONAL training course on the use of radioisotopes in agricultural research, organized jointly by the Ministry of Food and Agriculture, Government of India, Food and Agriculture Organization, International Atomic Energy Agency and Unesco South Asia Science Co-operation Office, will be held at the Indian Agricultural Research Institute, New Delhi, during January 20–February 17, 1960 The course will deal with the role of radiation in cytology and genetics, radioisotope techniques as applied to problems in soil fertility, fertilizer application and plant biochemistry and radiation as a protective agent Unesco has extended invitations to the Governments of Burma, Ceylon, India, Pakistan and Thailand A maximum of twenty-five participants will be admitted to the course Further information can be obtained from the Unesco South Asia Science Co-operation Office, 21 Curzon Road, New Delhi, India

The Night Sky in December

FULL moon occurs on Dec 15d 04h 49m U T and new moon on Dec 29d 19h 09m The following conjunctions with the Moon take place Dec 2d 06h, Saturn 4° S , Dec 26d 19h, Venus 2° S In addition to these conjunctions with the Moon, Mars is in conjunction with Antares on Dec 15d 16h, Mars being 4 4° N, Mercury with Antares on Dec 20d 08h, Mercury being 6 0° N, Mercury with Mars on Dec 25d 13h, Mercury being 1 0° N, Mercury with Jupiter on Dec 27d 01h, Mercury being 0 0° S, and Mars with Jupiter on Dec 29d 01h, Mars being 0 8° S Mercury will be visible as a morning star during the first three weeks of the month, rising almost two hours before the Sun, but conditions are not particularly favourable Venus is a morning star, rising at 3h 25m, 4h 00m and 4h 40m on December 1, 15 and 31, respectively, its stellar magnitude is −3 8 Its distance increases during the month from 77 to 98 million miles and the visible portion of the apparent disk increases from 0 598 to 0 714 Mars, Jupiter and Saturn are too close to the Sun for observation Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich Dec 13d 22h 10 3m, 75 Tau (*D*), Dec 20d 6h 09 4m, ο Leo (*D*), Dec 20d 7h 12 6m, ο Leo (*R*), Dec 27d 6h 34 1m, θ Lib (*R*), *D* and *R* refer to disappearance and reappearance, respectively The Geminid meteors are active during December 9–14 and the Ursids during December 20–22, but in neither case are conditions favourable for observation The winter solstice occurs on Dec 22d 15h

University News : London

DR G MORTON, lecturer at the London School of Economics and Political Science, has been appointed to the University readership in operational research tenable at that School

Titles have been conferred as follow professor of embryology on Mr Michael Abercrombie, reader in chemistry on Dr D J Millen, reader in botany on Mr P J Syrett, in respect of their posts at University College

Sheffield

THE following appointments to lectureships have been announced E Litton (civil engineering), L G M Sparling (mechanical engineering)

Announcements

THE firm of Blackie and Son, Ltd, has celebrated its 150th year of publishing Until very recently, all the scientific and technical publishing was conducted from Glasgow, but now a publishing department has been set up at the firm's London office to handle this type of book, and Mr Christopher T Rivington has been appointed London scientific editor

MR A S D BARRATT, technical director of Edwards High Vacuum, Ltd, since 1945, is resigning from the board of the Company at the end of the year to become an independent consultant His long association with the Company will, however, be maintained by his appointment as technical consultant to the Company, thus providing a liaison between the large-scale developments of vacuum technology now taking place and the long-term developments of the Edwards international group of companies

THE Iron and Steel Institute is devoting the main sessions at its autumn general meeting during December 2–3 to the forging and extrusion of steel The meeting is being held in the Great Hall, Caxton Hall, London Further information can be obtained from H Cleere, Iron and Steel Institute, 4 Grosvenor Gardens, S W 1

A SYMPOSIUM on the Exploitation of Natural Animal Populations, sponsored by the British Ecological Society, will be held at the Durham Colleges, University of Durham, during March 28–31 Full details can be obtained from E D Le Cren, The Ferry House, Ambleside, Westmorland

THE University of Texas M D Anderson Hospital and Tumour Institute announces the fourteenth Annual Symposium on Fundamental Cancer Research, "Cell Physiology of Neoplasia", to be held during February 25–27 Further information can be obtained from the Editorial Office, The University of Texas M D Anderson Hospital, Texas Medical Center, Houston 25, Texas

THE Department of Civil Engineering and the Department of Extra-Mural Studies in the University of Birmingham have announced a course on River Pollution Sewage Disposal and Trade Waste Treatment, to be held at the University of Birmingham during January 4–8, 1960, and continued during April 4–8, 1960 The course is arranged in co-operation with the Institute of Sewage Purification Further information can be obtained from Mr R F Wills, Civil Engineering Department, The University, Edgbaston, Birmingham 15

FURTHER to the announcement in the September 19 issue of *Nature* regarding the availability of the "Great Soviet Encyclopædia" in Britain, a complete translation into English of the fiftieth volume of the second edition will be published by Pergamon Press, Ltd, early in 1960 under the title of "U S S R Information" This is an authorized translation, produced with the full co-operation of the editor-in-chief of the "Great Soviet Encyclopædia".

CHEMISTRY IN THE EIGHTEENTH CENTURY

AN international meeting was convened in Paris during September 11–13 by the Comité National Francais d'Histoire et de Philosophie des Sciences in the name of its president, Prince Louis de Broglie It was timed to follow on the ninth International Congress on the History of Science, held this summer in Spain, and some of those attending did in fact reach Paris via Barcelona The invited contributors were asked to review topics such as phlogiston, the discovery of the gases, the preparation of non-gaseous chemicals, the reformation in chemistry, affinities, chemical biographies and works, chemistry and eighteenth-century science

Final arrangements were completed by M Maurice Daumas (Conservatoire National des Arts et Métiers) and he proposed to some thirty participants, when they assembled at the Conservatoire, six sessions incorporating twenty-five speakers, who would each be allowed thirty minutes for reading and discussion of their announced memoir This Procrustean principle, genially supervised by the sessional chairman, worked out surprisingly well A provocative précis, giving time for a rapid-fire of terse, ready commentaries in French or English, often threw very helpful flash-lights on an unfamiliar subject

The largest single groups attending were from France and the United States, but a useful British contingent accompanied the representatives of Eastern Germany, Eire, the Soviet Union, Sweden, Switzerland and Yugoslavia Some others, including Douglas McKie, were unable to attend, but this was a notable, perhaps a unique concentration of interest and authority on the history of chemistry

Reference to individual contributions must be invidious It is in any event the intention of the sponsors to publish, under a separate cover, the proceedings of this colloquium These again surveyed such pivotal pillars of progress as Boerhaave, Black, Priestley and Lavoisier If perhaps too little was heard on Henry Cavendish and J B Richter, other figures such as Bergman, Crawford, Cullen, Geoffroi, Kirwan, de Morveau, Scheele, Tillet and Watt were exhibited in refreshing detail

To the minority of professional chemists in attendance, there may have been something a whit rarefied in the attention given to Maupertuis and Gaspard Monge, but these were balanced by the stiffly practical consideration given by Academician Arthur Birembaut to early gas-manipulation or by F Greenaway to contemporary analytical chemistry None surely will forget the calm finality with which G Kersaint buried the unsavoury legend of the treachery of Fourcroy to Lavoisier, Figourovskij straddling the difficulties of language and time in his projection of Lomonossov, Claude Secretan's cool, systematic appraisal of scientific personalities, the charming intervention of M Braise, who now occupies the pharmacist's shop once served by Lavoisier's mentor, Guillaume-Francois Rouelle

The formal sessions were extended to the lunch-table, where the exchangers of criticism, literature-reference and citation could communicate their ideas There was also an exciting inspection of new acquisitions from Lavoisier's laboratory apparatus (By an educative coincidence, Blériot's original biplane apparatus, in this jubilee year, was seen suspended from the ceiling of another room) The foreign guests were permitted a privileged visit to the chemical archives of the Academy, an inspection of note-books by Lavoisier, and a glimpse of the meeting-rooms with their antique velvet, gilt frames, classic mouldings and individual microphones

Personal and renewed impressions were of the countless historical trails that lead back to Newton and Boyle, the accepted importance of the chemistry of the Scottish universities in the eighteenth century, the long-delayed development of Stahlian doctrine in the hands of Macquer and Rouelle, the painstaking, sharp rescrutiny of the contributions by Lavoisier to chemical theory, the muddled yet stimulating notions of affinity, the factors and persons which foreran Dalton An intimidating confusion of early schools and ideas, acquiring a laboured, significant sequence as the simple gases were isolated and understood, and there is still much historical material to arrange and digest before such studies bring full benefit

In their development of chosen themes by address or in debate practically every speaker was mindful of the broader canvas against which the chemical feature must be examined There was careful attention to contemporary physics, metallurgy and pharmacy, to economics and invention; even inevitably to politics, with some good-humoured interventions on delicate French and Irish situations Here were specialists indeed, but specialists determined on an adequate setting of their studies even to "The Fifteen", the Mountain and Vinegar Hill Humanism kept breaking in

Much more than the usual formalities of praise must go to the organization of this conference. Informal, urbane, efficient, friendly, it produced the sadly impractical conviction that such meetings should be held more frequently, and always convened in Paris Of still more lasting importance was the sense of community created Historians of science and especially, one imagines, historians of chemistry must generally plough a somewhat lonely furrow, although there are seemingly a few sites of adequate appraisal and support Here was the refreshment of friendly controversy, of actual and potential collaboration, and an atmosphere in which chemistry was seen as something even more than a magical technique, seen as a major factor in the climactic development of scientific method and modern science, as a bright particular strand in the culture pattern of Western mankind On these last points the eighteenth century had already no doubts at all

In some closing words of appreciation, Henry Guerlac used his graceful bilingualism to express our thankful sense of pleasure and profit from this occasion and hinted at a possible opportunity of meeting American colleagues in 1962 None commented on the very sparse German attendance or on the Italian absences which some later colloquium will surely find improved

ANDREW KENT

FAST CHEMICAL REACTIONS IN SOLUTION

VERY many chemical reactions in solution proceed too rapidly to be studied by conventional techniques, which require times of at least several seconds for their manipulation. Slower reactions often involve several steps, all but one of which are fast. It is also generally true that the simplest and most fundamental reactions tend to be fast ones.

The development of electronic methods of detecting and recording has made it possible to record almost any physical parameter in a very short interval of time and therefore to carry out a chemical investigation. But, in order that such an observation shall be significant, it is necessary to initiate the chemical change in some way in a time which is short compared with the time of reaction. Methods of attaining this and some of the results obtained were the subject of a recent meeting organized by the Bunsengesellschaft für physikalische Chemie and the Max-Planck-Gesellschaft. The colloquium was held in Hahnenklee/Harz during September 14–17 and was attended by about one hundred and sixty scientists, of whom about ninety were from Germany, thirty from the United States, twelve from Britain and twenty-eight from other countries. Thirty papers were presented, covering practically every available method.

The first two days were devoted to a discussion of the fast-reaction methods and measuring techniques themselves. Historically the first method was the rapid-mixing method introduced by Hartridge and Roughton thirty-six years ago, and this was discussed by F. J. W. Roughton (University of Cambridge) with particular reference to the reactions of hæmoglobin, for which the method was first developed. It has been extended and modified in many ways, for example, by the introduction of stopped-flow techniques, and is useful for half-reaction times of about 1 millisecond or more. Flash photolysis, developed by Norrish and Porter, is a second generally useful method, and in describing this method G. Porter (University of Sheffield) pointed out that almost every type of reaction can be initiated photochemically, and that at present it is possible to measure bimolecular reaction-rates with velocity constants up to 10^{10} litres/mole/sec and first-order constants up to 10^{5} sec^{-1}.

Q. H. Gibson (University of Sheffield) described how the stopped-flow method has been used to study the combination of hæmatin and carboxy-hæm with globin. Examples of the application of the flash photolysis method were given by H. Linschitz and J. Eloranta (Brandeis University), who used this method to study metal and hydrocarbon ion solutions, by H. T. Witt, who gave an extensive survey of the work which he and his co-workers have carried out on chlorophyll with particular reference to primary processes of photosynthesis, and also by E. W. Abrahamson (Syracuse University), who described work on the visual pigments.

Both mixing and flash-photolysis methods are applicable to systems which are far removed from equilibrium as well as to relaxation systems. Most of the other fast-reaction methods start with a system at equilibrium, displace the equilibrium slightly by changing some physical parameter and then observe the rate of relaxation to the new equilibrium position. Dr. M. Eigen and his colleagues at the Max Planck Institute for Physical Chemistry in Göttingen have been pioneers in this field, and a comprehensive review of relaxation methods and an account of the mathematical procedure and of the assumptions necessary to evaluate rate constants from the experimentally determined parameters was given by L. De Maeyer. Displacement can be either periodic or of the jump type, and temperature, pressure, field impulse and sound absorption are all used to produce the disturbance. K. Tamm (University of Göttingen) gave a survey of the use of the sonic relaxation method for rate measurements in water solutions. M. Eigen summarized many reactions which have been studied by relaxation methods. The fastest reactions which are controlled by diffusion give rate-constants of about 10^{10} litres/mole-sec for ionic reactions other than protonic where values of about 10^{11} litres/mole/sec are obtained. The use of the ultrasonic technique to study association reactions and rotational isomerizations was outlined by Van W. Maier (University of Freiburg) and J. Lamb (University of London) respectively, and the application of the relaxation method to enzymatic reactions was discussed by R. A. Alberty and G. G. Hammes (University of Wisconsin).

A new and very powerful approach to fast reactions is provided by the methods of electron and nuclear magnetic resonance. A molecule, such as water or hydrogen peroxide with two equivalent protons, gives a single peak in its nuclear magnetic resonance spectrum. A mixture of water and hydrogen peroxide will give two separate peaks if there is no exchange between the protons of the two molecules. However, if there is a fast exchange of the protons, there will be only one peak as all the protons will then appear equivalent. For intermediate cases the exchange-rate constants may be calculated from the form of the spectra. The nuclear magnetic resonance method can be used for reaction times from 1 to 10^{-3} sec. Electron spin resonance spectra can be interpreted in an analogous way to determine reaction-rates with characteristic times in the range 10^{-4} to 10^{-9} sec.

The carbon dioxide – water equilibrium has been studied by A. Patterson and R. Ettinger (Yale University) using nuclear magnetic resonance methods. Patterson pointed out that two most interesting questions remain unanswered, namely, why is such a large proportion of carbon dioxide in solution present in dissolved but not hydrated form, and, secondly, why is the hydration reaction such a slow process. R. G. Pearson (Northwestern University) explained how paramagnetic ions in solution affect the line-shape and how line-width can be used to measure exchange rate constants for reactions of complex ions.

Methods which are not quite so general in their application include the fluorescence method—A. Weller (Technischer Hochschule, Stuttgart) described how it is used to measure the fast reactions of excited molecules—and electrochemical methods. R. Brdicka (University of Prague), Jiri Koryta (Academy of

Science, Prague) and others gave comprehensive reviews on the use of polarographic technique in the study of electrode reactions

The transfer of electronic excitation energy between molecules is a special type of fast reaction which, in some cases, is so efficient that rate constants exceed those calculated for the maximum rate of a diffusion-controlled reaction using normal collision diameters Prof Th Forster (Technischer Hochschule, Stuttgart) explained how the interaction in such cases occurs through dipole–dipole coupling so that energy transfer can take place over distances as great as 50 A Two examples of the direct measurement of energy transfer processes were presented S S Brody (University of Illinois) has used a small specially designed hydrogen lamp to produce a flash of a few millimicroseconds duration He measured the delay between the flash and the fluorescence of chlorophyll in the chloroplast By using suitable filters, other pigments apart from chlorophyll were made to absorb the light and the sensitized fluorescence of chlorophyll was studied M Burton and H Dreeskamp (University of Notre Dame) were also able to resolve decay times of about 10^{-9} sec A low-voltage X-ray tube was used to deliver an approximately square wave pulse of about 10^{-8} sec duration with rise and fall times each about 10^{-9} sec By this means the energy transfer from benzene to *p*-terphenyl was measured

Papers by H Eyring (University of Utah) and R M Noyes (University of Oregon) dealt with questions of solution structure and fast reactions Noyes has developed a simple theory to predict the quantum yield for iodine dissociation from the values of the viscosity of the solvent, the sizes and masses of the fragments of dissociation, the energy of the bond that is broken and the energy of the absorbed quantum The agreement between theory and experiment is remarkably good for such a simple model

A very pleasant feature of the meeting was a visit to the Max Planck Institute in Gottingen, where a number of experiments on fast reactions in solution were demonstrated This visit provided a unique opportunity to compare and contrast many of the methods discussed at the colloquium The methods demonstrated included (1) flow methods, (2) relaxation methods—field impulse, temperature and pressure jump and sound absorption (3) polarographic methods, and (4) the nuclear magnetic resonance method

A lively discussion followed most of the sessions and was greatly facilitated by an excellent earphone translation system between the German and English languages Most of us left the meeting feeling that, with such a wealth of excellent methods available, there is now practically no chemical reaction in which rate cannot be directly measured, and the 'instantaneous reaction' has gone for ever It was also clear that reactions which proceed in times of less than one second are as numerous and at least as fundamentally important as those which allow a more leisurely approach to rate measurement

G PORTER
F WILKINSON

SWISS SOCIETY FOR NATURAL SCIENCES

THE one hundred and thirty-ninth annual meeting of the Swiss Society for Natural Sciences was held at Lausanne during September 11–13. The annual president, Prof A Girardet (Lausanne), opened it, with an address on "La science, le savant et le pharmacien", touching the history and psychology of pharmaceutical teaching, practice and research, which in Switzerland are the concern of the universities and medical authorities far more closely than in Britain in the general pattern of scientific and industrial development He pointed out in conclusion the financial handicap implied by the present-day loss of monopoly for the sale of many types of drugs, which has forced the pharmacist to extend his business to non-pharmaceutical products to the detriment of his professional standing Once the equals of the surgeon in the employ of the medical theorist, the pharmacist and pharmacologist have not fought their way to the same independence and supremacy as he has

The first general meeting adjourned to St Croix in the Jura Mountains, a geological and industrial district of considerable interest, in magnificent weather enjoyed with mixed feelings by the inhabitants, entirely dependent on wells for their water Prof A de Muralt (Berne) reported on the first seven years of the Swiss National Fund for Scientific Research, State subsidized but remarkably free from State control, and available to Swiss organizations and individuals in the widest conceivable manner Nuclear research has naturally come in for a large share, and its potentialities and limitations in Switzerland were discussed separately in more detail by Prof P Huber (Basle), who has been most concerned with it

The remainder of the general proceedings took place in the fine painted Aula of the University of Lausanne, adjoining the magnificently re-organized up-to-date library and the Museum of Fine Arts, where one of the hospitable receptions was held, all of them pleasantly devoid of any visible host or formality of any kind

After an illuminating account by P Muller, of the Paris Observatory, on "Le Pourquoi des Satellites Artificiels", and a masterly and moving survey, "La Science à la Recherche d'une Conscience", by the annual vice-president, Prof D Rivier (Lausanne), the day ended with a report by Dr G Chevallaz (syndic of Lausanne) on preparations in hand for the Swiss National Exhibition to be held in 1964 at Lausanne in better circumstances, it is to be hoped, than its predecessors of 1914 in Berne and 1939 in Zurich

Finally, at the third general meeting, Dr F Kaudewitz, of the Max Planck Institute of Tubingen, spoke on "Methoden, Denkweise und Ergebnisse der Erbforschung an Bakterien", with a sober simplicity, clarity and directness remarkable in so new and complex a domain, and the *sous-directeur* of the National Museum of Natural History at Paris, T Dorst, under the title "La Signification des Galapagos pour l'Étude de l'Évolution", gave the latest findings and hypotheses on these unique islands

The meeting was timed to coincide with the annual Comptoir Suisse at Lausanne, in order to give Swiss residents the advantage of return travel at single fare by means of an automatic ticket-stamping device inside the Comptoir, with a reduced entrance fee for members of the Society The simultaneous disadvantage that hotels had to be booked long in advance kept away a certain number of members Nevertheless, the sectional proceedings were on the whole as lively and well attended as ever, the Geophysical, Meteorological and Astronomical Section in particular being fortunate in having the director of the Swiss Meteorological Station, Prof J Lugeon, at hand in person after his extensive travels of recent years, partly in connexion with the International Geophysical Year and two of them to the North Pole, to report, with collaborators, on "Les Recoupements Radiogoniographiques des Grands Foyers Orageux de l'Hémisphere Nord depuis la Base Spitzberg-Suisse (4100 km)" and "Comparaison des Régimes des Parasites Atmosphériques Polaires et Européens", and to give a preliminary report on measurements of atmospheric electricity and radioactivity of the air at Murchison Bay during the International Geophysical Year The History Section was specially interesting with reports on the mathematical aspect of the Hippocratic Logos (Dr Lichtentaeler, of Leysin), on Baldasar Heseler's eyewitness account of Vesalius's first public anatomy lecture at Bologna in 1540 (Dr N Mani, of Basle) and on the little-known mathematician and philosopher de Crousaz, of Lausanne, 1663–1750 (Dr Ed Fueter, of Wadenswil, ZH) Perhaps the Physics Section was the busiest, under the annual vice-president, Prof D Rivier, with twenty-eight papers mainly on metal, crystal and atomic physics

Excursions after the meeting were organized for those interested in geology (3 days), mineralogy (2 days) and botany (2 days)

R C H Tanner

SCIENCE AND THE LIBRARY SERVICES IN BRITAIN

THE programme of the annual conference of the Library Association usually includes two or three papers of some general scientific interest and, although that of the annual conference held at Torquay during September 22–25 was possibly of less scientific interest than usual, Prof Lancelot Hogben's "Past, Present and Future of the Printed Page", Sir Sydney Roberts's "Reflections on the Roberts' Report", and Alderman F J Stott's "The Public Library as a Major Instrument of Education" are of wide interest Besides this, Miss M E Wilden-Hart's "Observations on County and Municipal Practice" touched on various matters involved in the development of an adequate national library system whether for science and technology or in any other field Earl Attlee's presidential address, succinct, wise and witty, illustrated the extent to which wide reading and the right handling of books are still positive constructive factors in modern life , and Lady Barlow discussed "Charles Darwin as Author"

Prof Hogben addressed himself to three issues Can other means of communication adequately replace the printed page ? Will their rightful exploitation diminish the demand for the printed page relative to the size of the literate public ? And how far does a plan of peaceful co-existence for the two call for a new programme of book design ? On the first, Prof Hogben remarked that 'adequately' was the operative word, and the freedom to turn the pages backwards or forwards to interpret the author's meaning in the light of previous statements or of what occurred later was an incentive to concentrated attention and acted as a brake on superficial assent To regard reliance on mechanized instruction without reliance on the printed page as calamitous did not mean that the more extensive use of sound or television should be regarded with disfavour or that such extension would curtail the need for book learning On the contrary, Prof Hogben thought that we would have to exploit new means of instruction and that radio sound and television could solve the modern problem of shortage of talented teachers in a world of wider educational opportunities if—and only if—we could give it a curricula orientation entirely divorced from the prepossessions of the entertainment business The exploitation of the newest visual aids did not mean that there would be need for fewer books in the near future In some of the backward territories there would be vastly more readers if we could use the new means to speed up universal literacy, and where literacy was already well-nigh universal the new means could so expand the appetite for learning as to stimulate powerfully the output of new informative literature

As regards the third question, while there was no reason to anticipate that the exploitation of the new means at our disposal would diminish the demand for the printed page, and ample reasons existed for believing that it would increase that demand, we could certainly forecast that it would increasingly change the content of what printed matter is in demand and set a new standard of design for books which satisfy an abiding demand Here Prof Hogben referred to the possibilities opened up by gearing issued and printed material into editions which could subserve two educational objectives, sentences of one line in length permitting repetition of the same message line by line in several languages In the new era the first challenge to intellectual effort was how most expeditiously we could make available to all persons everywhere the printed page , the second was how to make everywhere accessible to all, both one and the same printed page and one and the same human voice The third great intellectual challenge was how to disperse over an ever-widening and deepening understanding less of the mechanical techniques at our disposal than of the peculiarly human innovations

Sir Sydney Roberts began by pointing out that the central question his Committee had been asked to consider was what changes, if any, should be made in the administrative arrangements of the public library service, and this included possible transferences of responsibility from one type of library authority to another Although there were obviously two clashing views of the functions of a public library, both were agreed that the public library service, by whatever type of authority it might be administered, was essentially a feature of local government. Nevertheless, the Committee was clear that provision of library facilities should cease to be a local option and should become a statutory duty with ultimate authority vested in the Minister of Education. Librarianship, however, was a highly specialized function, and in Sir Sydney's view a committee responsible for a public library should be an independent committee reporting direct to the library authority. Directing attention to the Committee's comment that size and efficiency did not necessarily march together, and its view that full opportunity—at least three years—should be given to any non-county borough or urban district to demonstrate its ability to fulfil the required conditions before any change was made in its library status, Sir Sydney said that the Committee had had before it the proposals for the new National Lending Library for Science and Technology, and its consideration of such matters had confirmed its misgivings about the imperfections of the reference sections in many libraries. Co-operation between libraries of an entirely different character and constitution, however, could best be achieved by individual negotiation, in the light of local conditions, between the libraries concerned. The main obstacle to higher efficiency in the working of the regional bureau, however, was finance, and the Committee was not prepared to advocate a standard pattern of administration over the whole country. Finally, after touching on the problems of book selection, financial and otherwise, Sir Sydney pointed out that the public libraries must take full account of the implications of the scientific revolution in which we live. They must stock both the technological text-books and reference books needed by their industrial and academic clients and they must make a judicious choice of those authors who attempt to explain the basic principles of scientific development to the non-scientific reader. They had also to recognize the sociological results of scientific discovery and development and meet adequately the recreational needs of leisure.

Alderman F. J. Stott, who began with a quotation from the report of President Eisenhower's Science Advisory Committee, "Education for the Age of Science", stressing that the aim of an educational system must always be the development of the individual so that he could live the fullest life with himself and the community, elaborated further Sir Sydney Roberts's closing remarks. If the scientific age challenged technologists to make a special effort to ensure that their education was not detrimental to their balanced development as individuals and challenged non-technical people to keep in touch with the new language and thoughts of science, it was essential for our national welfare that we should stay in communication with each other, and the channels of communication could only be secured by the universal enjoyment of liberal education. Education, however, was being required to devote more and more of its resources to vocational and technical training at the expense of wider values, and while at work more and more were called upon to do less and less thinking, in our ever-increasing leisure more and more were content to leave the planning of their leisure to the instruments of mass entertainment.

In this situation, in which the integrity and full flowering of the individual were threatened on all three counts, Alderman Stott thought that the public library had an important part to play. A survey of readers recently made in the Plymouth public libraries indicated that, whereas in Plymouth 33,000 scholars at primary, secondary and grammar schools spend 33.5 million hours in attendance, 66,000 readers of all ages devoted 36.5 million leisure hours to reading, of which 15 million were devoted to reading of a deliberately self-chosen, informative and educational character. On the provision of this service some £80,000 a year was spent, compared with about £2 million on formal education in primary and secondary schools, but Alderman Stott, of course, emphasized that on two-thirds to three-quarters of the population the public library services made no impact at all. He did not think it was simply a matter of increasing the provision for public library services but rather, as Lord Attlee had suggested, for encouraging children early in life to use and cherish books. There was also need for much more publicity and some attempt to meet the needs of individuals.

INDUSTRY AND HEALTH IN BRITAIN

THE annual report of the Chief Inspector of Factories for the year 1958 follows the new form adopted last year, which was very well received, and there is again a separate report on industrial health (Ministry of Labour and National Service. Pp. 95. (Cmnd. 810.) London: H.M. Stationery Office, 1959. 5*s*. 6*d*. net). While the number of reported accidents fell by 4 per cent, from 174,713 to 167,697, and was the lowest reported for any year since 1935, fatal accidents rose from 651 to 665. For factories alone the figure declined by 5 per cent to 143,099, of which 368 were fatal; but in building operations and works of engineering construction there were increases from 14,568 to 15,017 and from 1,924 to 2,329, respectively. The former included a considerable increase in fatalities due to falls, especially of materials, and this appears to be due to much demolition work being carried out by inexperienced personnel with little or no appreciation of the loading and stresses in various parts of the structure on which they are working. No figures are available for accident incidence rates of individual industries, although the report gives comparative frequency rates, based on voluntary returns from individual firms, and it is hoped to publish a table of incidence rates in next year's report. The distribution of accidents between the sexes and between young persons and adults was little changed, but the report points out that, in spite of the emphasis placed on training young persons entering industry, 9,838 young persons were involved in notifiable accidents and 8 of them were killed. In some industries it is still true that the probability of an accident is greater for a young person than for an adult

The Chief Inspector directs attention to the increase in accidents due to transport other than rail, where the 1958 figure was more than double that for 1948, and to the need for much more attention to problems of safety in the use of road transport within factories and other work-places greater care, for example, might be exercised in selecting drivers and operators of such transport Accidents associated with the use of power presses again increased in spite of great efforts to evolve better designs and methods of guarding, and greater attention to maintenance of these machines and their guards appears to be needed

The new arrangement of the report gives prominence to the aspects of special interest to the scientist There is a separate chapter on the problems encountered by the Inspectorate in relation to nuclear energy and ionizing radiations, which covers electrical instrumentation and the control of nuclear reactors, as well as the preparation and fabrication of special metals used in reactors, the preparation of enriched uranium, the handling and treatment of irradiated fuel rods and sealed and open sources of radiation A chapter on fire prevention stresses the need to report dangerous occurrences which are not associated with personal injury, and attention is directed to the possibilities of eliminating sources of ignition by less hazardous arrangements as well as to the hazards associated with waste and with the handling of inflammable liquids even on a relatively small scale The limitations of devices based on developments in modern telecommunications techniques are discussed and special attention is directed to the hazards associated with organic peroxides Here and for the handling of mercury the report details a number of specific precautions, and the advantage of placing any potentially explosive plant, such as that for handling hydrogen, outside any occupied room and where explosion is unlikely to injure anyone if it occurs, is indicated The scientific interest of the work of the Inspectorate is further illustrated by the list of interdepartmental committees on which inspectors have served, and the report records 407 inspectors of all grades in posts at the end of the year with vacancies for nine general, eleven chemical, eight engineering and two medical inspectors

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THE BRITISH FORESTRY COMMISSION

THIRTY-NINTH ANNUAL REPORT

AS remarked in the opening sentence of this report*, by far the most important event of the year in British forestry was the statement on policy made in Parliament In view of the developments and progress since the post-war policy was adopted in 1946, planting is to continue at approximately the current annual rate of 60,000 acres for another five years, after which a significant reduction, about a fifth, is envisaged, when the older plantations will be coming into full production at an age of around fifty years There is no specific abandonment of the old national target of five million acres of productive woodland for Britain as a whole, though it is recognized that its strategic basis has altered considerably No specific target is set for the planting of private woodlands, currently running at 32,000 acres annually, but the policy of encouraging planting and more intensive management is continued, the acreage grants being raised and somewhat modified Action is also being taken to improve the marketing of produce from these private woodlands as it has long been recognized as unsatisfactory, with consequent discouragement to owners and potential investors The increased grants were offered on condition that owners organized an effective association for marketing and connected purposes, and they have in fact now done this on a regional basis ; at the same time, the warning is given that the grants are not to be viewed as a permanent subsidy, but only as an initial stimulus and help which should fairly soon become unnecessary Felling licences will be continued, not to restrict felling to a predetermined quota, but to ensure acceptable felling practices and replanting where necessary

Once again, difficulties in acquiring the necessary land for the annual planting programme constitute a major handicap, and the necessity of paying rather higher prices than in the past is accepted It is hoped that more land will become available particularly in Scotland and Wales, where the expansion of forestry will provide diversification of employment and important social benefits

Although one of the most direct benefits of increased timber production in Great Britain should obviously be a gradual reduction of imports which run at present at around £170 million per annum, we should now be entering a phase of quite considerable development of wood-based industries , this should more than compensate for some drop in consumption of unprocessed wood, such as has occurred with pit-props and railway timbers The opening of a large hardwood pulp mill on the Severn estuary is an important event and is being followed by similar developments in various parts of Great Britain The possibilities of small-scale pulping are under special consideration and seem quite promising

Expenditure on research now stands at more than £300,000 annually A short summary of progress in the several branches of the work is included in this report though a full account is published separately Research facilities have been greatly improved during the year by the provision of a large new building which was formally opened in July

Reviewing the situation as a whole, it is clear that the decision taken forty years ago to remedy the extremely unsatisfactory forestry position in Britain has been acted on with a measure of success that rarely attends such long-term ventures, and we are now rapidly approaching the time when the returns, both direct and indirect, will be coming in at a rapidly increasing rate already sales of produce are bringing in more than £3,000,000 in the year

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* Forestry Commission Thirty-ninth Annual Report of the Forestry Commissioners for the year ended 30th September 1958 Pp 84+7 plates (London H M Stationery Office, 1959) 5s net

ULTRASONIC BARIUM TITANATE ADHESION AND PASTE TRANSDUCERS

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PRELIMINARY observations on the behaviour of two new types of transducer will be described to emphasize the possible importance of these generators They offer possibilities particularly in overcoming the following problems which arise in applying transducers available at present

(1) For the generation of elastic waves in solids at very high frequencies, a quartz crystal of a thickness of 0 1 mm —having a fundamental resonance frequency of approximately 30 Mc /s —is, due to fragility, the smallest thickness that can be used in practice

(2) The coupling layer between the transducer crystal and the test object should be as thin as possible, preferably less than $\lambda/20$ This again sets a limit for high-frequency applications

Exciting a crystal in its harmonic modes is not always a reliable method and does not solve the coupling problem The importance of extending the frequency-range is summarized in ref 1

(3) In addition, in non-destructive testing, the degree of coupling between an ultrasonic transducer and object is unknown[2] A firm and stable contact is desirable, but is especially difficult to obtain at rough and curved surfaces

(4) The resonance frequency of a crystal transducer is not variable—a disadvantage in some applications

New desirable transducer types and manufacturing methods are mentioned in ref 3

A transducer produced on the surface, forming an integral part with the test block, would avoid the handling of extremely thin crystals and the necessity of providing a coupling layer This is obviously not possible with conventional barium titanate transducers[4], because during the production a temperature of 1,350° C is required which cannot be tolerated for most test objects

The Barium Titanate Adhesion Transducer

Barium titanate powder was mixed with a liquid ethoxyline and heated to remove moisture After allowing this mixture to cool to a few degrees above room temperature, a hardener was added and the mixture was cast on the surface of a metal block (Fig 1) A ring made from an electrical insulating material of the same thickness as the desired ultrasonic transducer was placed on the surface of the metal block forming a casting mould for the mixture. Immediately after casting, while the mixture was still in a 'plastic' stage, a flat metal disk was placed on top of the ring The disk and the metal block form the electrodes and two defining surfaces of the mould A high-voltage direct current source was connected through a resistor to polarize the transducer, while simultaneously the electrical output of a conventional ultrasonic reflectoscope[5] was applied via a condenser The reflectoscope transmitted short electrical pulses to the transducer cast When the cast became operative as a transducer its performance could be deduced by observing the pulses reflected from the far end of the test block The metal disk and the casting mould ring were coated with a thin layer of a silicone paste before assembly It was found that this was sufficient to isolate the elastic vibrations of the transducer from the top electrode By thorough cleaning of the metal surface of the test block an intimate elastic coupling to the case was obtained The unit was heated to approximately 135° C and allowed to cool to room temperature, while the high-voltage source and the reflectoscope were still connected During this operation the mixture became a solid layer in firm contact with the test block, hence the name adhesion transducer

The reflexion from the far end of the test object was observed and showed an increase in amplitude with decrease in temperature The behaviour was tested by applying the pulses at carrier frequencies 0 5, 1, 2 5 and 5 Mc /s , which were available from the reflectoscope, to the same adhesion transducer

The majority of the subsequent tests were carried out at 2 5 Mc /s with a pulse length of 1 μsec The temperature cycle was repeated several times and the same result as described above was obtained On heating a polarized adhesion transducer while the direct voltage source was disconnected, a decrease

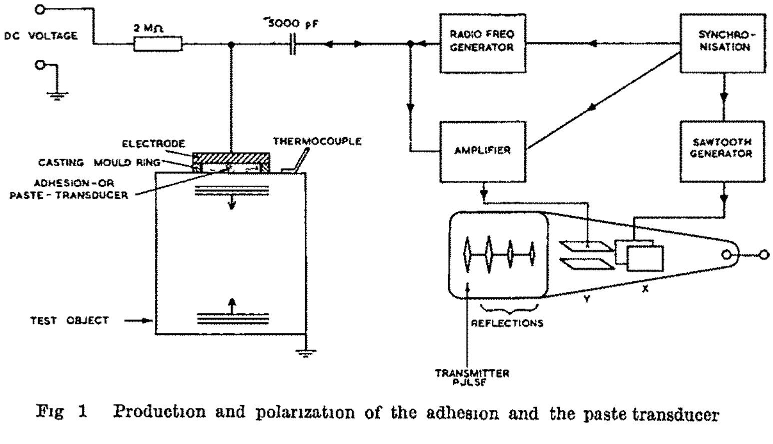

Fig 1 Production and polarization of the adhesion and the paste transducer

of the amplitude of the reflexion was observed If the temperature exceeded 135° C the amplitude dropped to zero and the transducer was depolarized On heating a polarized transducer without the d c field to a maximum temperature of, say, 120° C, which is below the Curie temperature of conventional barium titanate transducers, its piezo-electric properties recover after cooling down but the amplitude of the reflexion does not increase to the original value

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While the optimum composition of the mixture from which the adhesion transducer was made is still being investigated, an attempt has been made to determine the effect of different barium titanate powder sizes One problem for further investigation would be to test the expected usefulness of the adhesion transducer as a generator for high-frequency elastic waves Since it can be expected that the relation of wave-length to grain size will be important in determining high-frequency limitations, the following tests were carried out Because no electronic apparatus with higher carrier frequencies than those already mentioned was available, coarser powder was used while the frequency was held constant in an effort to obtain an estimate of the effectiveness of fine powder at correspondingly higher frequencies Powder diameters between $d = 50$ μm and 500 μm in five grades were available The velocity of sound of the transducer for compressional waves was found to be $2\ 7 \times 10^5$ cm /sec The following measurements were also made at a carrier frequency of 2 5 Mc /s The corresponding ratios of the wave-length in the transducer to the powder diameter d were $21 > \lambda/d > 2\ 1$ No significant differences in the observed reflexion amplitudes were observed, the coarse grain transducer ($\lambda/d = 2\ 1$) seeming if anything to be slightly more effective

The electrical impedance of the adhesion transducer was found to be considerably higher and the dielectric constant considerably smaller (ε_r approximately 7) than the corresponding values for conventionally made barium titanate transducers

The adhesion transducer as described was hardened for a few minutes at a temperature above 100° C The polarization of the transducer made from fine powder was effective only if the temperature exceeded 135° C On the other hand, the use of coarse powder in making adhesion transducers allows an important modification of the manufacturing procedure The remarkable effect was observed that they could be polarized by application of a d c field at room temperature, while the transducers were still in the 'plastic' stage forming a thick paste The hardening can take place at room temperature, but hours or days are required, the actual time depending on the mixing ratios, the physical dimensions, and ambient temperature This modification is important where test objects cannot tolerate a temperature of 135° C After the transducer has hardened to a solid layer, it can be de- or re-polarized only above 135° C in the manner already described

The Barium Titanate Paste Transducer

The procedure for manufacturing a paste transducer is identical with that described at the end of the last paragraph, except that no hardener is added to the mixture and only grain sizes above a certain value are useful The mixture remains a paste independent of temperature and time It is polarized at room temperature The first polarization curve and the hysteresis loop of the de- and re-polarized curve are shown in Fig 2

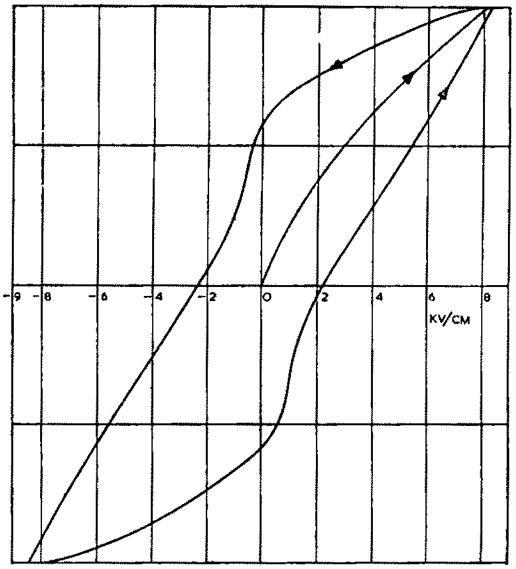

Fig 2 Ferro-electric hysteresis of a paste transducer Amplitude in percentage of the reflexion from the far end of the attached test block as a function of the polarization field in kV /cm Measured at 2 5 Mc /s , and 25° C

The paste transducer can be de-polarized (i) by means of stirring the paste , (ii) by means of a d c field of an appropriate negative value (see Fig 2) The behaviour of these paste transducers was totally unexpected in that unlike conventionally made barium titanate transducers and the adhesion transducer it was found still to operate above 135° C Even at 200° C a reflexion amplitude of 66 per cent and at 300° C of 40 per cent of the value measured at room temperature was observed The piezo-electric performance of the paste transducer is also less dependent on temperature than that of the adhesion transducer

A paste transducer made from finer powder was found to be less effective, and for the finest available size no piezo-electric effect was measured An obvious advantage of the transducer in paste form would be that by altering the distance between the upper disk electrode and the test block, using a casting mould ring of an elastic material, the transducer could be tuned to $\lambda/2$ for a given frequency of the electrical oscillator

Stability of Performance of the Transducers immediately after Polarization

After removing the polarization d c voltage on a paste transducer it was found that the amplitude of the reflected pulse decreased from 100 to 63 per cent in approximately 10 sec , and to 60 per cent (as shown in Fig 2) during the subsequent minute, after which it remained practically constant No further ageing could be observed over a period of two weeks

By adding a hardener, as described for the production of the solid adhesion transducer, a hardening time of several days can be arranged using a suitable low temperature The following remarks concern a transducer with a final hardening time of two days Immediately after the hardener was added the same behaviour as mentioned above for the paste transducer was observed Removal of the polarization field 2 hr after the addition of hardener increased the 100 to 63 per cent reflexion decay-time mentioned previously, from 10 sec to several minutes. In later stages between the 'plastic' and solid state this time may further increase to several hours. No decay was observed after the transducer layer had become a solid.

Some Aspects of the Application of the New Transducers for the Non-destructive Testing Technique

A useful application of the transducers is in the non-destructive testing of objects having a rough or curved surface. Unlike conventional transducer probes they are in direct contact with the object. Furthermore, no damping block on the back of the crystal is required for increasing the frequency band-width, as is necessary in conventional transducers, because the mechanical damping of most test objects is sufficient even at a rough surface. Detuning of the transducer, having a band-width, caused by a rough or irregular surface, is not of importance in practice; this can be corrected by re-tuning in the case of the paste transducer, as already mentioned above. At rough surfaces a reflectoscope, operating with the new transducers, should be capable of detecting cracks with a smaller area or at a greater distance from the transducer than is possible with a conventional apparatus. The so-called 'dead zone' would also be smaller because the transducer band-width is wider and therefore shorter pulses can be applied.

Theoretical investigation and further experimental work are continuing to (*a*) explain the observed ferro-electric and dielectric behaviour; (*b*) extend the frequency-range of the transducers by considering, for example, possible spray and evaporation techniques for obtaining physically thin layers.

I thank Mr J D N van Wyk of the National Physical Research Laboratory for valuable discussions, and Mr E R Schmidt for preparing the barium titanate powder.

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INCORPORATION OF N-METHYL CARBON OF MONOMETHYLAMINOAZOBENZENE INTO POLAR DYES

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AND

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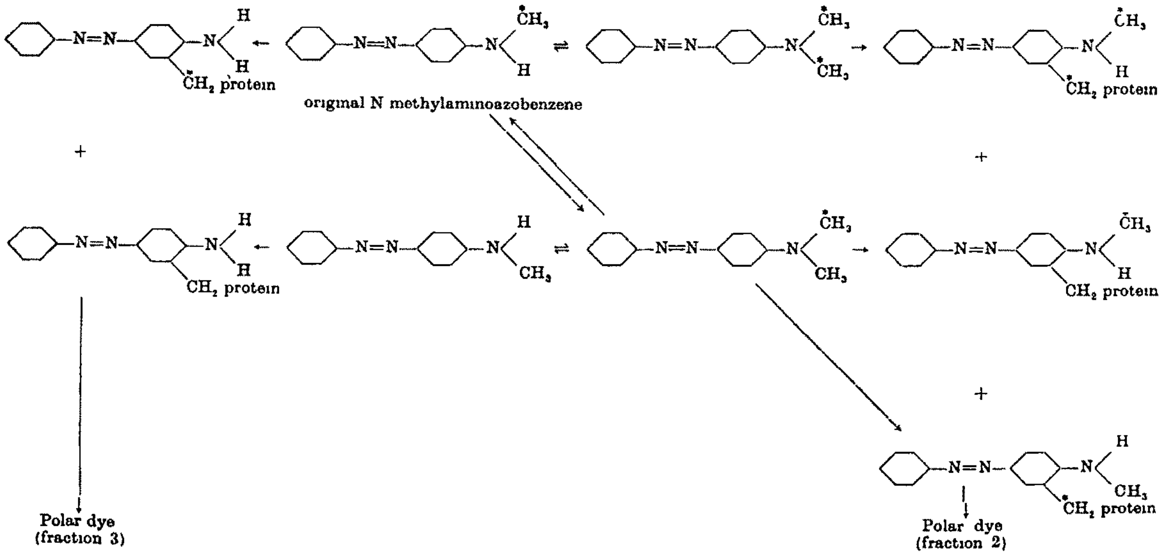
THE chemical binding between carcinogenic aminoazo dyes such as dimethylaminoazobenzene and cellular protein of rat's liver was first discovered by the Millers[1], who then proposed the protein deletion hypothesis as the basis of chemical carcinogenesis.

The chemical nature of the binding, however, has not been sufficiently investigated, due to the difficulty of purifying the polar dyes from the hydrolysate of the dye-bound liver proteins as well as the small amounts available. Terayama *et al* recently studied the purification of the natural polar dyes from the hydrolysates of the dye-bound rat liver proteins[2,3] and discovered the presence of at least two types of polar dyes, depending on the nature of the amino group of the dye moiety, one having the primary (fraction 3) and the other having the secondary amino group (fraction 2)[3,4]. They also showed that the binding is at position 3, ortho to the amino group, in the dye moiety of polar dyes prepared from rat liver after the administration of dimethylaminoazobenzene or N-methylaminoazobenzene[3]. Evidence for position 3 binding is the remarkable spectral change (disappearance of the 500–520 mμ absorption in acid media) shown by the polar dyes after the 4 position amino group of the polar dyes is methylated up to the dimethylamino group with a mixture of formaldehyde and formic acid. The binding at position 4-amino group[5] was excluded so far as the acid-stable polar dyes (fractions 3 and 2) derived from dimethylaminoazobenzene or N-methylaminoazobenzene are concerned. This was confirmed by the result of the comparison with the synthetic acid-labile polar dyes which have the amino-acid substitution at the amino group (Mannich base)[3,6]. The amino-acid which is responsible to the binding in the protein moiety was assumed to be tyrosine mainly from the strong Folin–Ciocalteau's reaction, ultra-violet absorption and stability against acid treatment of the polar dyes[3]. The bridge to bind the dye to the tyrosine residue was thought tentatively to be a methylene[3] or oxymethylene, —OCH$_2$— (unpublished work), group mainly on account of the necessity for at least one N-methyl group in the potent carcinogenic aminoazobenzene dyes as indicated by the Millers[6,7]. Direct evidence in support of the presence of a methylene (or oxymethylene) bridge has, however, been lacking. The present communication gives experimental support for the incorporation of the N-methyl group of N-methylaminoazobenzene into the polar dyes at a position other than the 4-amino group of the dye moiety.

N-^{14}C-methylaminoazobenzene was administered to rats and the polar dyes were prepared, fractionated and measured by the radioactivity as well as the optical absorption. 25 mgm of the labelled compound in 2 ml of olive oil was administered intragastrically under ether anæsthesia. The rats thus treated were killed 3 days later, livers removed and the polar dyes prepared as described in earlier papers. The partially purified mixture of polar dyes in 2 *N* hydrochloric acid was submitted to '*IRC*-50' (*H* type) column chromatography. The dyes were adsorbed at the top of the column, washed with



Scheme for the formation of protein-dye *in vivo* upon the administration of labelled N-methylaminoazobenzene

2 *N* hydrochloric acid, water and 30 per cent alcohol successively and then eluted with 60 per cent alcohol Three fractions were separated The portion not removed with 60 per cent alcohol was then eluted with 2 *N* ammonia (fraction 4) Fraction 1 seems to be contaminated with a small amount of non-polar dye Fraction 2, a major component, having absorption maximum at 522 mμ in 2 *N* hydrochloric acid in 50 per cent alcohol, is the polar dye with the secondary amino group, and fraction 3, a minor component, having absorption maximum at 514 mμ in the same solution, is the polar dye with the primary amino group Fraction 4 seems to be a mixture of the polar dyes with the longer polypeptide chains and can be further fractionated after being hydrolysed again The acid-stable fractions 2 and 3 were rechromatographed The radioactivity and the optical density measurements for the portions of the eluates are closely paralleled

The specific radioactivities of the purified polar dyes (fractions 2 and 3) are listed in Table 1 Since we do not know the exact molar extinction coefficients of the polar dyes, the amount of the fraction 2 polar dye is expressed in terms of N-methylaminoazobenzene or 3-methyl-N-methylaminoazobenzene, and for the fraction 3 polar dye in terms of aminoazobenzene or 3-methylaminoazobenzene tentatively It is very interesting to see that the polar dye having the primary amino group, fraction 3, still holds an appreciable amount of the radioactivity derived from the N-methyl group of the original N-methylaminoazobenzene This demonstrates clearly that the N-methyl group of the latter is certainly incorporated into the polar dye at a position different from the position 4-amino group The specific activity of fraction 2 polar dye seems to be greater than that of fraction 3, the original radioactive N-methylaminoazobenzene being intermediate Although the comparison of radioactivity in a strictly quantitative sense should be suspended until the exact molar extinctions of the polar dyes are elucidated, the result obtained here might be explained by assuming that the N-methylaminoazobenzene administered is further methylated *in vivo*, as indicated by the Millers[8,9], via the methyl pool, which is partly endogenous and partly derived from N-methyl metabolism of the radioactive N-methylaminoazobenzene, thus forming doubly labelled dimethylaminoazobenzene, which is then metabolized in the liver It seems reasonable to assume that fraction 2 polar dye is derived from the latter thus formed *in vivo* and the fraction 3 polar dye from N-methylaminoazobenzene, the radioactivity of which might be somewhat diminished *in vivo* as the result of the intracellular demethylation and methylation reactions, as shown in the accompanying scheme

Table 1 (*a*) YIELD OF POLAR DYES

From five rats, 25 mgm N-methylaminoazobenzene in 2 ml olive oil per rat

Polar dyes	Yield (γ) (in terms of N-methylaminoazobenzene)
Total polar dye, unfractionated	72 5
Fraction 1*	15 3
Fraction 2	30 7
Fraction 3	16 9
Fraction 4	5 4

* A part of fraction 2 is mixed in this fraction

Table 1 (*b*) SPECIFIC RADIOACTIVITY OF THE PURIFIED POLAR DYES

Polar dyes	Specific radioactivity (c p m /γ)
Fraction 2	580 ± 27 (in terms of N-methylaminoazobenzene) *c* 580 (in terms of 3-methyl-N-methylaminoazobenzene)
Fraction 3	224 ± 18 (in terms of aminoazobenzene) *c* 270 (in terms of 3-methyl-N-methylaminoazobenzene)
N-^{14}C-methylaminoazobenzene (administered)	430 ± 22

We wish to thank Prof F Egami and Mr K Kusama for their interest and valuable discussions A part of the expenditure was covered by the grant from the Scientific Research Fund of the Ministry of Education of Japan

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OXYGEN-CONTAINING FUNCTIONAL GROUPS IN THE ORGANIC MATTER OF A PODZOL SOIL

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IT has long been recognized that there is a close connexion between the mobilization and immobilization of metals and that of organic matter in the development of podzol soils. The mechanism involved remains obscure, largely because little is known about the chemical constitution of the organic material(s) moving from the *Ao* through the *Ae* into the *B* horizon of the profile. It seems reasonable to assume that the organo-metallic reactions involved depend on the nature and numbers of functional groups. For this reason, a systematic study was undertaken of such groups in the organic matter of the *Ao* and *Bh* horizons of the Armadale soil, a poorly drained podzol from Prince Edward Island[1]. This report deals only with oxygen-containing functional groups.

The organic matter from both horizons was extracted with 0·5 *N* sodium hydroxide solution. Parallel extractions were made under air and under nitrogen in order to evaluate possible effects of air-oxidation[2]. Following extraction, the organic matter of the *Ao* horizon was dialysed exhaustively against distilled water, while that of the *Bh* horizon was passed over 'Amberlite *IR*-120' exchange resin in order to remove most of the inorganic cations. Both extracts were then concentrated to near dryness on the steam-bath and finally dried at 100° C. under nitrogen. Where extractions were made under nitrogen, the most stringent precautions were taken to exclude air during extraction and purification. Wherever possible, the analytical data were checked by independent methods. Total acidity was measured by baryta absorption under nitrogen[3] and carboxyl groups by reaction with calcium acetate and with iodate–iodide[4]. Total hydroxyls were determined by acetylation[4,5] and phenolic hydroxyls by reaction with barium hydroxide[6] and by a modified Ubaldini procedure[7]. All hydroxyl determinations were made under nitrogen. Carbonyl groups were measured by the method of Brooks *et al.*[8] and methoxyls by Zeisel's method[9]. Ultimate analyses were done by dry-combustion. Infra-red spectra were recorded on a Perkin–Elmer Model 21 spectrophotometer, using potassium bromide pellets[10].

Irrespective of whether extractions were carried out under nitrogen or air, the material from the *Ao* was higher in carbon, hydrogen and nitrogen but lower in sulphur and oxygen than that from the *Bh* horizon (Table 1). A comparison of the results for functional groups in the *Ao* and *Bh* materials extracted under nitrogen showed that: (*a*) the *Bh* material was considerably more acidic, due entirely to the presence of more carboxyl groups; (*b*) the *Bh* organic matter was higher in total and consequently alcoholic hydroxyls since the phenolic hydroxyl content of both materials was similar; (*c*) there was little difference in the carbonyl content, and (*d*) the *Ao* organic matter contained more methoxyl groups (possibly because of the presence of undecomposed lignin).

Table 1. ANALYTICAL CHARACTERISTICS

Elementary composition (per cent) (dry ash-free basis)	*Ao* material extracted Under N	*Ao* material extracted Under air	*Bh* material extracted Under N	*Bh* material extracted Under air
Carbon	56·92	57·16	50·22	49·50
Hydrogen	5·20	5·30	3·74	3·62
Nitrogen	2·34	1·87	0·72	0·67
Sulphur	0·70	0·68	1·30	1·33
Oxygen (by difference)	34·84	34·99	44·02	44·88
Ash (dry basis)	8·87	8·25	3·02	3·85
Functional groups (m.-equiv. per gm. dry ash-free organic matter)				
Total acidity	4·7	4·7	11·4	11·5
Carboxyl	1·5	1·9	8·2	8·6
Total hydroxyl	3·2	6·0	5·0	5·1
Phenolic hydroxyl	3·2	2·8	3·2	2·9
Alcoholic hydroxyl (total minus phenolic)	0	3·2	1·8	2·2
Carbonyl	6·0	3·6	6·2	5·5
Methoxyl	0·4	0·4	0·2	0·2

The results for total and alcoholic hydroxyls (difference between total and phenolic) may be high, since total hydroxyls were determined by acetylation with acetic anhydride. This reagent[11], besides reacting with hydroxyls of primary and secondary alcohols and of phenols, also reacts with sulphydryl groups and primary and secondary amines. What proportion of the total nitrogen and sulphur is present as such groups is not known.

The most important changes in the distribution of functional groups when the organic matter was extracted under air (in contrast with nitrogen) were the following: (*a*) a decrease in carbonyl and an increase in alcoholic hydroxyl groups suggesting, in part, some form of keto-enol transformation; (*b*) a small increase in carboxyls and a concomitant equivalent decrease in phenolic hydroxyls. Durie and Sternhell[12] found a similar 1 : 1 correspondence between the decrease in phenolic hydroxyls and the increase in carboxyls on oxidizing brown coal in alkaline solution in the presence of oxygen. They concluded that the increase in carboxyl groups arose from phenolic groups.

There were no changes in the total acidity and methoxyl content of the organic matter whether extracted under air or under nitrogen.

Table 2 shows that whereas all the oxygen of the *Bh* organic matter was found in the functional groups, only 60 per cent of the oxygen of the *Ao* material

Table 2. DISTRIBUTION OF OXYGEN IN FUNCTIONAL GROUPS

	$\frac{\text{O as COOH}}{\text{Total O}}$	$\frac{\text{O as OH}}{\text{Total O}}$	$\frac{\text{O as CO}}{\text{Total O}}$	$\frac{\text{O as CH}_3\text{O}}{\text{Total O}}$	$\frac{\text{O accounted for}}{\text{Total O}}$
Ao material extracted under nitrogen	0·14	0·15	0·28	0·02	0·59
Ao ,, ,, ,, air	0·15	0·27	0·16	0·02	0·60
Bh ,, ,, ,, nitrogen	0·60	0·18	0·23	0·01	1·02
Bh ,, ,, ,, air	0·61	0·18	0·20	0·01	1·00

Table 3 MAJOR BANDS AND RELATIVE ABSORBANCES IN THE INFRA-RED OF EXTRACTED ORGANIC MATTER

Frequency (cm $^{-1}$)	Relative absorbance *Ao* organic matter	 *Bh* organic matter	Interpretation*
3,380	strong	strong	hydrogen bonded —OH and bonded —NH groups
2,910	medium	shoulder	aliphatic C—H stretching vibrations
2,840	medium	0	,, ,
2,600	shoulder	shoulder	carboxyl
1,720	shoulder	strong	carboxylic carbonyl
1,620	strong	strong	joint interaction of hydroxyl and carboxyl with carbonyl (ref 13), also possibly carboxylic groups associated with metals so as to give the carboxylate structure (ref 11)
1,450	strong	0	CH_3 and/or CH_2 in plane deformation vibrations
1,400	0	medium	carboxylate
1,250	weak	0	phenoxy C—O
1,200	0	medium	carboxyl
1,030	medium	0	Si—O of silica due to the presence of clay

* After Bellamy (ref 14) unless stated otherwise

was similarly distributed The remaining 40 per cent was probably present as ring and/or ether oxygen Unfortunately, all systematic errors which occurred in the determination of the other oxygen groups are accumulated in this figure (O accounted for)

The information from infra-red absorption spectra (Table 3) confirmed the chemical evidence with regard to the presence of the major oxygen-containing functional groups In addition, the infra-red spectra suggested that the *Ao* material was more aliphatic in nature than the *Bh* material There were no detectable differences in the infra-red spectra whether the organic matter was extracted under nitrogen or air

The major functional groups (carboxyls, hydroxyls and carbonyls) found in the organic matter of both horizons are known to react with metals such as iron and aluminium Therefore, the presence of large numbers of such groups, especially in the organic matter of the *Bh* horizon, offers a partial explanation for the observed reactivity to metals of this type of organic matter during the formation of podzol soils

We acknowledge the technical assistance of J G Desjardins and R Levick

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ACTIVE PRINCIPLES OF THE NEUROHYPOPHYSIS OF COLD-BLOODED VERTEBRATES

Chromatographic and Biological Characteristics of Fish and Frog Neurohypophysial Extracts

THE neurohypophyses of all mammals so far investigated contain oxytocin and arginine vasopressin, with the exception of that of the pig, which contains oxytocin and lysine vasopressin There are some indications, however, that the active principles in the glands of other vertebrate classes may differ from the mammalian peptides For example, it has been shown[1] that, in frogs kept in water, the increase in weight produced by the injection of the extract of a single frog pituitary is matched by about 1,000 mU mammalian oxytocin but that, assayed on a mammalian uterus, a frog gland contains only about 40 mU oxytocic activity A similar difference in the ratio of activities has been shown by Sawyer[2] in the bullfrog

In view of these indications, it was decided to investigate further the active principles in non-mammalian neurohypophysial extracts The pituitary glands of three species of fish (trout, cod and pollock) and of frogs (*R temporaria*) were used Extracts of these glands produced oxytocic, vasopressor, antidiuretic, milk ejection and frog water-balance effects The oxytocic and vasopressor activities were completely abolished by treatment with sodium thioglycollate The resistance of the other activities to such treatment has, as yet, not been investigated

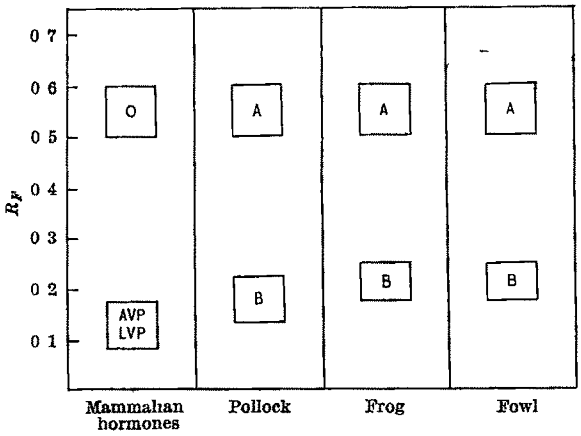

Fig 1 Descending paper chromatograms of acetic acid extracts of mammalian and non-mammalian pituitary glands The squares represent areas from which active substances could be eluted Oxytocin (*O*), arginine vasopressin (*AVP*), lysine vasopressin (*LVP*), fast-moving oxytocic activity (*A*) and slow-moving oxytocic activity (*B*)

When subjected to descending paper chromatography in butanol/acetic acid/water (4 1 . 5) and stained by the method of Heller and Lederis[3], eluates containing oxytocic activity were obtained from two regions of the paper (Fig 1) Eluate *A*, which was obtained from the same region as mammalian oxytocin, contained only a trace of antidiuretic activity and no pressor activity could be detected Thus, almost all the pressor and antidiuretic activity of the original extract was found in eluate *B* Both eluates caused milk ejection in the lactating rabbit and an increased uptake of water in frogs As Fig 2 shows, however, the frog water-balance effect of eluate *B* was much greater than that of eluate *A*

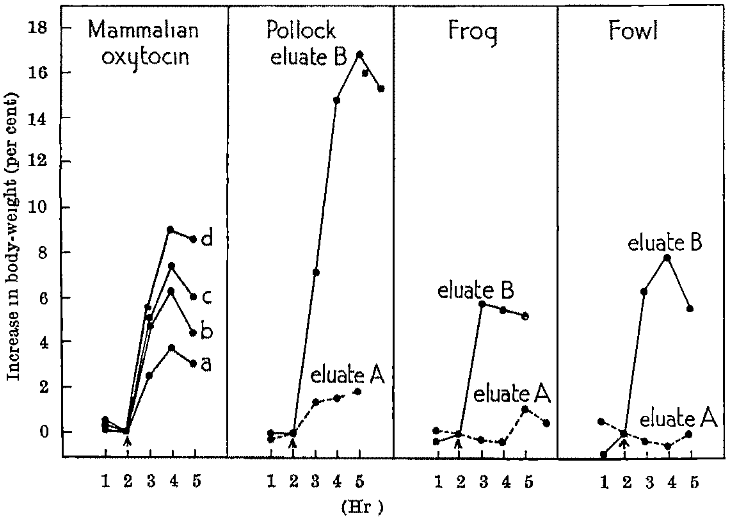

Fig 2 Effects of eluates *A* and *B* (see Fig 1) on frog water-balance The volumes of eluates injected per frog had the following activity as assayed against synthetic oxytocin on the isolated rat uterus Pollock, eluate *A*, 76 mU , eluate *B*, 101 mU Frog, both eluates, 7 5 mU Fowl, both eluates, 12 3 mU (*a*) 100 , (*b*) 300 , (*c*) 600 , (*d*) 900 mU oxytocin Injections at arrow The results shown are the mean responses of five or six frogs

It would seem, therefore, that the pituitaries of the three teleosts (two sea-water and one fresh-water species) and the amphibian investigated contain at least two oxytocic hormones, one of which behaves chromatographically and pharmacologically much like mammalian oxytocin The other, which differs from the vasopressins in its marked oxytocic and frog water-balance activity, also seems to occur in fowl posterior pituitaries (Fig 1) These results raise the interesting possibility that the hypothalamus of the vertebrate classes mentioned elaborates oxytocin and another active peptide not present in mammalian glands

We should like to thank Dr Grace Pickford for kindly supplying the pollock pituitary powder used in these experiments

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Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates

Munsick, Sawyer and van Dyke[1] have reported that chicken neurohypophysial extracts contain two active polypeptides One appears to be oxytocin A second peptide, present in greater quantity, has pharmacological and chromatographic characteristics indistinguishable from those of arginine vasotocin

Arginine vasotocin was synthesized by Katsoyannis and du Vigneaud[2] and kindly supplied by them for pharmacological study in this Department It is unique among the neurohypophysial hormones and analogues that we have studied in that it has activities on the isolated hen or turtle oviduct, on frog water-balance and diuresis, and on water transport across the bladder-wall of the frog far greater than one would predict from its vasopressor and oxytocic potencies

Heller[3,4] demonstrated that neurohypophysial extracts from fish, frog, snake and pigeon have frog water-balance activity much greater than that of mammalian extracts This observation suggests that they contain a peptide active on frog water-balance that is neither oxytocin nor vasopressin Since arginine vasotocin is such a peptide and has been tentatively identified in the avian neurohypophysis, we have studied neurohypophysial extracts from cold-blooded vertebrates to determine if their pharmacological characteristics are consistent with those of arginine vasotocin

Extracts from the green turtle (*Chelonia mydas*), the bullfrog (*Rana catesbiana*), the common American toad (*Bufo americanus*), the pollack (*Pollachius virens*), and the marine lamprey (*Petromyzon marinus*) were assayed by rat vasopressor, rat antidiuretic, rat uterus with and without magnesium, rabbit milk-ejection, hen oviduct, and isolated bullfrog bladder assays[1,5,6] The ratios of potencies by pressor, antidiuretic, hen uterus and frog bladder assays were, in each case, completely consistent with the relative activities of arginine vasotocin on these assays In all but *Petromyzon* there was more rat uterus and milk-ejection activity than could be due to arginine vasotocin alone This is consistent with the assumption that oxytocin is also present in all but the lamprey

One extract of the neurohypophysis of *Squalus acanthias* (spiny dogfish) has also been subjected to this series of assays Its pharmacological profile is not that of arginine vasotocin, oxytocin, or of any analogue that we have yet studied

We can advance the hypothesis, therefore, that arginine vasotocin and oxytocin occur in birds, reptiles, amphibians and teleosts Arginine vasotocin also appears in the most primitive living vertebrates, the cyclostomes The one elasmobranch studied appears to possess an active peptide unlike any that we have encountered elsewhere among the vertebrates

This investigation was supported by grants *A*1940 and *H*1788 from the National Institutes of Health, U S Public Health Service, and from the N Y Heart Association and the Smith, Kline and French Foundation

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Arginine Vasotocin

IN connexion with the programme being carried out in this Department on the relationship of the structures of the posterior pituitary hormones to their biological properties, an analogue was synthesized[1] containing the ring of oxytocin attached to the side-chain of arginine vasopressin , for convenience, this substance was called arginine vasotocin This highly purified compound was tested for its uterus-contracting activity with the isolated rat uterus and for its pressor activity in the rat Our best information at the present time is that the arginine vasotocin has approximately twice the rat-uterus contracting activity and about one-fourth the rat-pressor activity of arginine vasopressin

Although the arginine vasotocin is not as active with regard to pressor activity as arginine vasopressin, the high pressor activity of the vasotocin is noteworthy in indicating the contribution to pressor activity of the basic amino-acid in the side-chain, since oxytocin, which differs from arginine vasotocin in having leucine in place of arginine in the side-chain, has approximately one-tenth the pressor activity of the arginine vasotocin The results also indicate that the phenylalanine in the ring of arginine vasopressin is of significance to pressor activity, since the vasopressin is more active than vasotocin, which has *iso*leucine in place of the phenylalanine Furthermore, the fact that arginine vasotocin has twice the oxytocic activity of arginine vasopressin indicates that *iso*leucine in place of phenylalanine raises the oxytocic activity In other words, replacement of phenylalanine by *iso*leucine has decreased the pressor activity and raised the oxytocic activity

Because of the interesting pharmacological properties of arginine vasotocin, a sample of the synthetic product was made available to Prof H B van Dyke for more extensive pharmacological investigation

In view of the strong evidence of the possible occurrence of arginine vasotocin in non-mammalian sources adduced by Sawyer, Munsick and van Dyke (preceding communication) and the possible correlation of their work with the results of Pickering and Heller (preceding communication) on the occurrence of an active peptide in certain non-mammalian vertebrate neurohypophyses, it was felt that this brief communication on arginine vasotocin would be appropriate

If subsequent chemical results substantiate the evidence for the occurrence in Nature of arginine vasotocin, the synthesis of the arginine vasotocin would represent a remarkable example of the synthesis of a polypeptide hormone before its identification as a natural product

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COUNTER-CURRENT DISTRIBUTION OF PROTEINS IN AQUEOUS POLYMER PHASE SYSTEMS

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THE method of counter-current distribution has been shown to be one of the most efficient tools for analysing mixtures of substances of biochemical interest such as polypeptides So far, it has mainly been applied to low molecular substances but recently a number of proteins such as insulin[1], adrenocorticotropine[2], growth hormone[2], lactogenic hormone[2], lysozyme[3,4], ribonuclease[4], casein[5-7], serum albumin[8], and hæmoglobin[9] have also been successfully distributed One of the advantageous features of counter-current distribution is that it is based upon several steps each involving a state of equilibrium between two liquid phases Generally a state of equilibrium is supposed to be more easily obtained between two liquid phases than between, for example, a solid phase and a liquid phase For macromolecules this difference in equilibrium behaviour may be expected to be more pronounced than for low molecular weight substances It would therefore be of the greatest interest if counter-current distribution can be applied also for large molecular weight substances such as proteins and nucleic acids Many difficulties present themselves, however, when carrying out liquid–liquid extractions of proteins Thus they show a general tendency, due to their large molecular size, to be distributed unilaterally and there is always a risk of denaturation which may be caused by the interfaces and the organic solvents of the phase system In some cases, for example, with serum albumin[8], these difficulties have been successfully avoided by introducing complexing agents such as trichloracetic acid The effect of these is to stabilize the protein against denaturation and to make it more soluble in the organic phase

The present communication describes another approach to overcome these difficulties, namely, the

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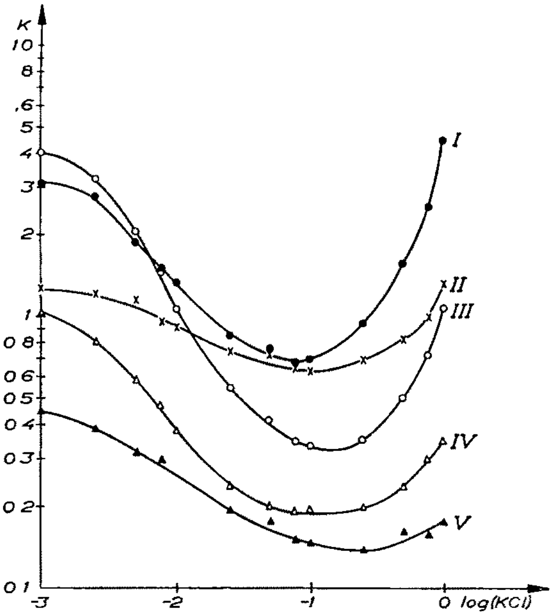

Fig 1 The partition coefficient (K) as a function of potassium chloride concentration for a number of proteins in a two-phase system of dextran and polyethylene glycol The curves represent phycocyanin (I), barley albumin (II), phycoerythrin (III), cæruloplasmin (IV), and human serum albumin (V) The system contains 0 005 mole potassium dihydrogen phosphate, 0 005 mole potassium monohydrogen phosphate, and potassium chloride as indicated, all per 976 ml of the phase system (976 ml is the volume of 1 kgm standard phase system which has a composition of 7 per cent (w/w) dextran, 4 4 per cent (w/w) polyethylene glycol, and 88 6 per cent (w/w) water) The protein in the two phases was estimated by determining the extinction at 545 mμ for phycoerythrin, the extinction at 620 mμ for phycocyanin, the nitrogen according to the Kjeldahl method for serum albumin, the enzyme activity for cæruloplasmin, and with the biuret method for barley albumin

use of aqueous polymer phase systems[10,11] based upon the fact that different polymer solutions in general are not miscible[12,13] These systems are obtained by mixing water solutions of two different polymers, for example, dextran and methylcellulose or dextran and polyethylene glycol Of the two phases in such a system the one phase usually contains most of one polymer and the other phase most of the other polymer The important point is that the water content is high in both phases and that the interfacial tension is very small Most proteins will, therefore, dissolve easily without denaturation This has been demonstrated for a number of proteins[11] and viruses[14] in a dextran–methylcellulose system The same system has also been used for the enrichment and purification of viruses[15,16] and for the fractionation of brain microsomes[17]

For the present study we have used a system of dextran and polyethylene glycol mainly because its phases have comparatively low viscosities, particularly the top phase (the polyethylene glycol-rich phase), which is the moving one In addition, reasonable times for phase separation (15–30 min) may be obtained by this system The following fractions of the polymers were found to give suitable conditions dextran with a viscosity number of 0 48 dl /gm ('Dextran 500' from Pharmacia, Uppsala, Sweden, and 'Carbowax polyethylene glycol 6000' from Carbide and Carbon Chemicals Co , U S A) A phase diagram of the system, and the way in which the polymers may be purified before use, will be described elsewhere[18,19] The phase system which has been used throughout contained 7 per cent (w/w) dextran and 4 4 per cent (w/w) polyethylene glycol, the rest being water or buffer The compositions of the upper and lower phases of this system at + 20° C are 0 2 per cent (w/w) dextran, 7 7 per cent (w/w) polyethylene glycol, 92 1 per cent (w/w) water and 14 4 per cent (w/w) dextran, 0 9 per cent (w/w) polyethylene glycol, 84 7 per cent (w/w) water, respectively The viscosities of the top phase and the bottom phase are about 4 and 60 centipoises, respectively

A striking characteristic of this system is the great dependence on the salt composition of the partition coefficient (K) for many proteins Thus, for example, phycoerythrin is mainly in the top phase ($K = 5$) in the presence of 0 01 M phosphate buffer (*p*H 6 8) If increasing amounts of potassium chloride are added the protein is pushed down into the bottom phase until a minimum value of $K = 0$ 33 is obtained Further addition of potassium chloride then causes the protein to be transferred to the top phase again Fig 1 serves to illustrate this salt effect for a number of proteins and it may be seen there that it is rather different for different proteins This salt effect has been studied systematically and will be described elsewhere[18,19]

The counter-current distributions were run on the two proteins phycoerythrin ($M = 290{,}000$) and phycocyanin ($M = 150{,}000$), which had been isolated from the red alga *Ceramium rubrum*[20] and purified by twice repeated chromatography on calcium phosphate[21] An automatic apparatus, constructed similarly to the Craig glass apparatus[5], was used The volumes of the phases were about 10 ml each, the settling time 35 min , and the number of shakings 50 The results from three experiments are given in Figs 2, 3 and 4 The aim of the two first experiments (Figs 2 and 3) was to see if the distribution of the protein followed the theoretical distribution law A K-value of about 1 was desirable for these experiments and the salt composition necessary to give this was selected with the aid of the curves of Fig 1 As may be seen in Figs 2 and 3, the experimental distribution curve fits the theoretical one very

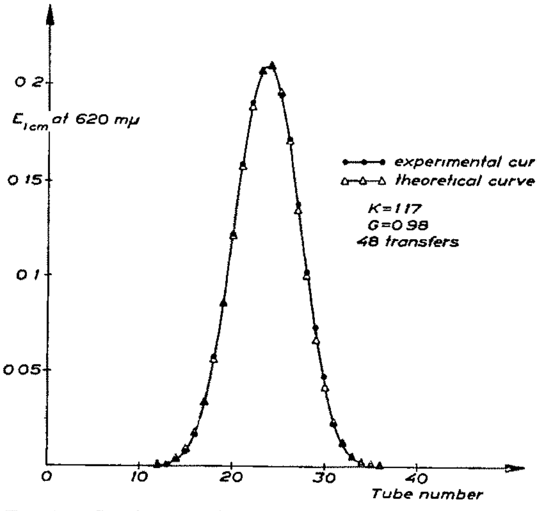

Fig 2 Counter-current distribution of phycoerythrin in a dextran–polyethylene glycol system containing 0 005 mole potassium monohydrogen phosphate, 0 005 mole potassium dihydrogen phosphate and 0 022 mole potassium chloride per 976 ml of the phase system The first tube was charged with 28 2 mgm protein Extinction was measured for samples from the bottom phase diluted with equal weight of water The K value was determined experimentally and the G value (the amount of protein in the top phase divided by the amount of protein in the bottom phase) was calculated from the position of the maximum of the experimental curve

well, indicating that the partition coefficient of the proteins in this phase system is a true Nernst partition coefficient. The salt mixture which would give a large separation factor necessary for the separation of phycoerythrin and phycocyanin could also be selected from the curves of Fig 1. Thus a salt concentration of 0·01 mole potassium phosphate and 0·75 mole potassium chloride per kgm. phase system was used in the experiment depicted in Fig 4. The *K*-value was determined experimentally for each tube. These are plotted in Fig 4, where it may be seen that while the *K*-value is fairly constant for phycocyanin it increases with the tube number for phycoerythrin, indicating heterogeneity for the latter protein. Such heterogeneity is also known from chromatography on calcium phosphate[21]. Heterogeneity could not, however, be revealed by precipitation tests according to Ouchterlony[22] since the phycoerythrin of the front and the trailing part of the peak gave identical reactions.

The proteins studied here are coloured and could easily be measured by their strong absorption in the visible spectrum. For uncoloured proteins the estimation of protein concentrations is more tedious. Thus, before measuring the ultra-violet absorption at 280 mμ the phases have to be diluted two to three times and then cleared by high-speed centrifugation for a few minutes. Even then it is sometimes difficult to get reproducible values when a small amount of protein is present. The dextran and polyethylene glycol interfere in the method of protein determination according to Lowry *et al.*[23] The biuret method[24] works for the polyethylene glycol-rich top phase. Nitrogen determination according to Kjeldahl may be used but this is rather time-consuming when many samples have to be analysed. A simple and rapid modification of these methods for protein estimation in a dextran–polyethylene glycol system is therefore needed.

There is no general method like, for example, dialysis for removing the polymers from the protein. On the other hand, there are so many other possibilities for achieving this purification that for a given protein a suitable method may usually be selected. Two ways in which phycoerythrin was recovered may serve as examples.

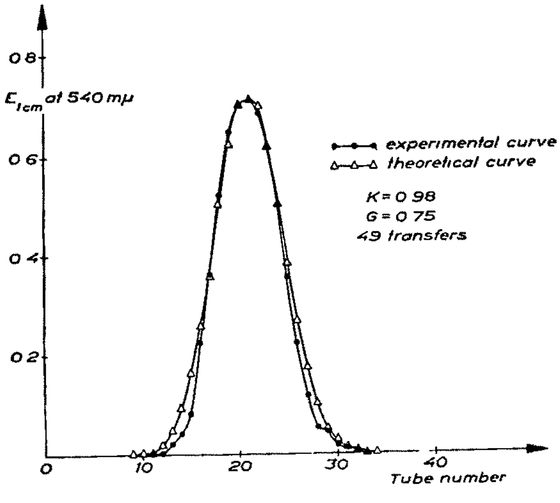

Fig 3. Counter-current distribution of phycocyanin in the same system as in Fig 2. The first tube was charged with 7 ml. of a solution of phycocyanin with an extinction of 20·3 when measured at 620 mμ in a 1-cm. cell. The *K* and *G* values indicated were obtained as in Fig 2

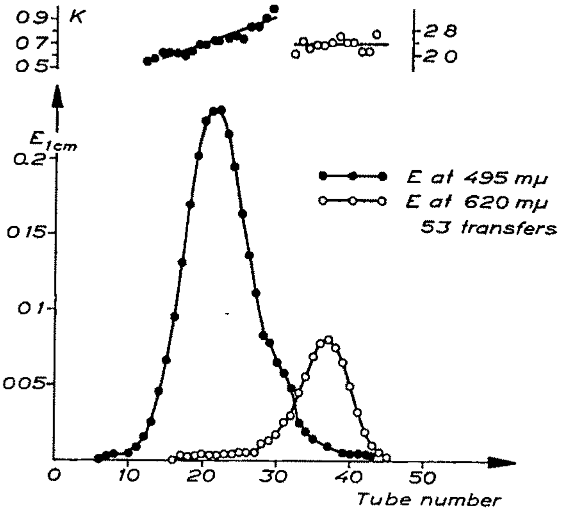

Fig 4. Counter-current distribution of a mixture of phycoerythrin (filled circles) and phycocyanin (open circles) in a dextran–polyethylene glycol system containing 0·005 mole potassium monohydrogen phosphate, 0·005 mole potassium dihydrogen phosphate, and 0·75 mole potassium chloride per 976 ml. of the phase system. The protein mixture was put into the first two tubes. The extinctions given are those of the top phase. The *K* values plotted above have been determined experimentally. The estimation of protein in the two phases was done by determination of the extinction at 495 mμ for phycoerythrin and the extinction at 620 mμ for phycocyanin

By the first method the mixture is passed through a column of calcium phosphate at 0·005 *M* potassium phosphate buffer (*p*H 6·8). The phycoerythrin is adsorbed while dextran and polyethylene glycol are not and they can therefore be washed away by the buffer. The phycoerythrin is then eluted with 0·1 *M* phosphate buffer. That the polymers had been washed away completely was checked by the anthrone method[25] for dextran and the method of precipitation of the barium derivative with phosphomolybdic acid for polyethylene glycol[26]. The presence of dextran and polyethylene glycol does not change the absorption capacity of calcium phosphate for phycoerythrin; it only reduces the time of flow.

The second method involves the following procedure: ammonium sulphate is added to 1·1 l. of a mixture containing the phycoerythrin, 3·5 per cent (w/w) dextran, and 2·2 per cent (w/w) polyethylene glycol until a concentration of 1 *M* is obtained. A top phase of 70 ml. is formed and contains all the phycoerythrin. It is dialysed against a 30 per cent (w/w) solution of polyethylene glycol containing 0·1 *M* sodium chloride and then added to 17 gm. of a 30 per cent (w/w) solution of a low molecular weight fraction of dextran (viscosity number 0·05). The phycoerythrin is almost entirely transferred to the small bottom phase of this system, which had a volume of 7 ml. and contained no polyethylene glycol. This phase is collected, dialysed, and the protein precipitated by the addition of ammonium sulphate.

All these procedures for the recovery of the protein have the advantage that the protein is concentrated into a small volume, a step which is often desirable prior to further purification or analysis.

We wish to thank Prof. A. Tiselius for his stimulating interest in this work, and Dr. L. Philipsson of the Institute of Hygiene and Bacteriology, Uppsala, for carrying out the immunological tests. The work has been aided financially by grants to the Institute of Biochemistry, Uppsala, from the Swedish Technical Research Council and from the U.S. Department of the Army through its European Office, under contract number *Da*-91-508-*EUC*-287 One of us (E J N) wishes to thank the Ministry of Education, Belgium, for a grant

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PROPERTIES AND INHERITANCE OF HÆMOGLOBIN BY ASYMMETRIC RECOMBINATION

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A MOLECULE of human adult hæmoglobin, which contains two types of polypeptide chains designated the α- and β-chains[1], dissociates into subunits α_2 and β_2 in dilute acid and re-associates to the native molecule $\alpha_2\beta_2$ in neutral solution[2,3] (A different nomenclature has been used in previous publications (refs 2, 4 and 5) Identification of the aberrant chain of hæmoglobin *S* (refs 7 and 8) permits adoption of a uniform nomenclature based on the proposal of Rhinesmith, Schroeder and Martin (ref 1) A comparative chart of the two systems of nomenclature has been given elsewhere (ref 3) Recombination of an acid-dissociated mixture of two hæmoglobins that differ from each other in one of the two pairs of chains results in exchange of the sub-unit common to the two forms without formation of new molecular species[2,4] Recombination of two hæmoglobins that differ from each other in both chains apparently results in formation of new molecular species[5]

The effect of recombining two hæmoglobins that differ in both chains has been observed in the present work with mixtures of human carbonmonoxyhæmoglobin *A* and canine carbonmonoxyhæmoglobin Acidification of equimolar mixtures of these hæmoglobins to *p*H 4 7 followed by neutralization[4] yielded two new electrophoretic components in addition to the original components (Fig 1) The absorption spectrum of the recombined mixture is the same as that of an untreated mixture Canine carbonmonoxyhæmoglobin migrates more slowly than carbonmonoxyhæmoglobin *A* at *p*H 6 8 One of the new components migrates more rapidly than *A* and the other migrates more slowly than the canine form The relative mobilities of these new components and increase in their proportions with time of exposure to dilute acid (Table 1) are consistent with the occurrence of a relatively slow exchange reaction in which mixed molecules are formed The net change (formation of new species at the expense of the original components) may be represented by the reaction

$$\overset{A}{\alpha_2}\overset{A}{\beta_2} + \overset{\text{can.}}{\alpha_2}\;\overset{\text{can}}{\beta_2} = \overset{A}{\alpha_2}\overset{\text{can}}{\beta_2} + \overset{\text{can}}{\alpha_2}\;\overset{A}{\beta_2}$$

(The α and β polypeptide chains of human hæmoglobin have been defined according to their N-terminal amino-acid sequences (ref 1) Since these sequences are not known for canine hæmoglobin, our use of this terminology here depends upon the fact that the chains of canine hæmoglobin appear to be configurational analogues of the α- and β-chains)

Table 1 COMPOSITION OF CANINE AND HUMAN HÆMOGLOBIN MIXTURES BEFORE AND AFTER RECOMBINATION

Dissociation time	Electrophoretic composition per cent of total*			
	New slow	Canine	*A*	New fast
Control	—	41	59	—
20 min	10	36	44	10
40 min	11	39	39	11
4 hr	22	28	32	18
22 hr	31	24	21	24

* All samples contained 50 per cent each of human and canine hæmoglobin before recombination Percentages shown are probably anomalous because of low concentration of buffer-ion

Vinograd, Hutchinson and Schroeder[6] and Ingram[7] have shown that the β-chain is the aberrant chain of hæmoglobin *S*, and Hunt and Ingram[8] have shown that the inherited amino-acid substitutions of hæmoglobins *S* and *C* occur in the identical chain position Recombination with hæmoglobins *S* and *C* of hæmoglobins *D*, *E* and *J* from families previously reported by one of us[9,10] resulted in no significant change in electrophoretic composition A component migrating between hæmoglobins *A* and *I* appeared when hæmoglobin *I* from the family reported by Rucknagel, Page and Jensen[11] was recombined with hæmoglobin *S* (Fig 2) Changes in composition were also observed when Hopkins-2 hæmoglobin[12] was recombined with hæmoglobins *S*, *C* and *J*.

No evidence of recombination was obtained from acidification and neutralization of mixtures of bovine carbonmonoxyhæmoglobin *A* (ref 13) with human carbonmonoxyhæmoglobin *A*, canine carbonmonoxy-

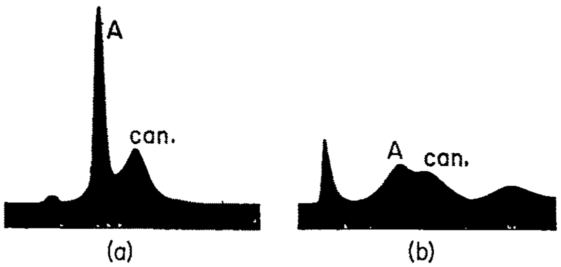

Fig. 1. Ascending limb electrophoretic patterns of 1 per cent carbonmonoxyhæmoglobin in phosphate buffer of *p*H 6.8, $\Gamma/2$ 0.02. The direction of migration is from right to left. (*a*) *A*, canine control. (*b*) *A*, canine recombined after 4 hr. dissociation at *p*H 4.7

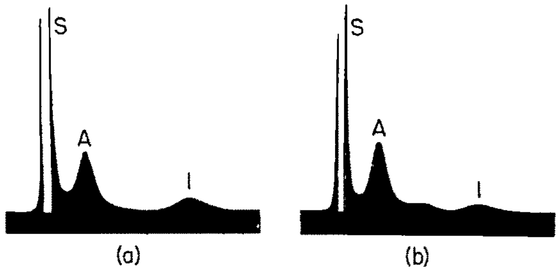

Fig. 2. Ascending limb electrophoretic patterns of 1 per cent carbonmonoxyhæmoglobin in phosphate buffer of *p*H 6.3, $\Gamma/2$ 0.02. The direction of migration is from right to left. (*a*) *S*, *A*, *I* control. (*b*) *S*, *A*, *I* recombined

hæmoglobin or bovine ferrihæmoglobin *A*. Human and canine carbonmonoxyhæmoglobins, which recombine with each other, also recombine with their respective ferrihæmoglobins to form an intermediate component. The postulated structure of this component, a molecule with two carbonmonoxyhæms and two ferrihæms, is the same as that of an intermediate compound in the oxidation of carbonmonoxyhæmoglobin to ferrihæmoglobin[2,14]. Although it is possible that sub-units of one hæmoglobin would be physically incompatible with those of another[4], it is not likely that sub-units which differ only in the chemical state of the hæms would be incompatible. Therefore the absence of an intermediate component in an acidified and neutralized mixture of the carbonmonoxy- and ferri- forms of bovine hæmoglobin indicates in all probability that the acidified mixture does not contain sub-units, that is, that bovine hæmoglobin, unlike human and canine hæmoglobins, does not dissociate at *p*H 4.7. This conclusion is consistent with other evidence of structural stability of the bovine hæmoglobin molecule, namely, its extremely high resistance to alkali denaturation[15].

These experiments suggest several applications of the recombination method. Reversible dissociability of a hæmoglobin under specified conditions can be tested by subjecting a mixture of its carbonmonoxy- and ferri- forms to these conditions. The altered chain of a dissociable abnormal hæmoglobin can be rapidly identified by electrophoretic analysis after recombination with a previously characterized dissociable form such as hæmoglobin *S*. Change in electrophoretic composition will presumably occur if the abnormal hæmoglobin dissociates reversibly and differs from hæmoglobin *S* in both chains; but no change will occur if it is abnormal only in the β-chain, the abnormal chain of *S*. Although some of our samples have not been tested for dissociability, the results in comparable cases agree with those obtained by Ingram[7] by chemical analyses. The donors of hæmoglobin *I* of our earlier report[5] and the present investigation are not known to be related. Both have mixtures of hæmoglobins *A* and *I* in their red cells; however, the proportions of *I* are different, about 60 and 20 per cent, respectively. The result in each case points to an α-chain defect in hæmoglobin *I*. The occurrence of an exchange reaction between human and canine hæmoglobins shows that these hæmoglobins have similar configurations at the surface of union of their respective sub-units in spite of large differences in amino-acid composition[16]. Isolation and chemical characterization of mixed molecules produced by recombination will permit identification of the chains in canine and other dissociable hæmoglobins that are configurational analogues of the α- and β-chains of hæmoglobin *A*.

According to Smith and Torbert[12], the gene controlling Hopkins-2 hæmoglobin segregates independently of that controlling hæmoglobin *S*. The changes observed in recombined mixtures containing Hopkins-2 hæmoglobin were small because the proportion of this form in the original sample, a mixture of *A* and Hopkins-2, was low. Nevertheless, the results in several experiments were always consistent with abnormality in the α-chain of Hopkins-2 hæmoglobin. Our results to date, together with the familial data of Smith and Torbert, are thus in accord with independent genetic control of the α- and β-chains. The hæmoglobin of double heterozygotes for *S* and Hopkins-2 has only three electrophoretic components, identified as *S*, *A* and Hopkins-2 (ref. 12), although random association of two different α-chain pairs and two different β-chain pairs, each of which is independently synthesized, would yield four molecular species. The fact that *S* and Hopkins-2 have opposite charge abnormalities with respect to hæmoglobin *A* may account for the apparent inconsistency. A molecule composed of abnormal β-chains from *S* and abnormal α-chains from Hopkins-2 would have approximately the same net charge as *A* and would not separate electrophoretically from *A*. The same mechanism has been proposed to explain the presence of only three electrophoretic components in recombined mixtures of hæmoglobins *C* and *I* (ref. 5).

A more detailed report of this work will be published. We are indebted to Dr. Ernest W. Smith for the sample of Hopkins-2 hæmoglobin.

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FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, December 7

Institution of Electrical Engineers, Electronics and Communications Section (at Savoy Place, London, W C 2), at 5 30 p m —Mr B B Jacobsen "Frequency Patterns for Multiple-Radio-Channel Routes"

University of London (at King's College, Strand, London, W C 2), at 5 30 p m —Prof Max Derruau (University of Clermont-Ferrand) First of three lectures on the "Central Massif of France" * (Further lectures on December 8 and 10)

University of London (at Queen Mary College, Mile End Road, London, E 1), at 5 30 p m —Dr M Eigen (Max-Planck-Institut fur Physikalische Chemie, Gottingen) "Relaxation Spectra of Fast Chemical Changes in Solution" *

Manchester Literary and Philosophical Society (in the Reynolds Hall, Manchester College of Science and Technology, Sackville Street, Manchester), at 5 45 p m —Dr J Needham, F R S "Hydraulic Engineering and Society in Ancient and Medieval China" (Wilde Memorial Lecture)

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W 1), at 7 p m —Mr G Pask "Discontinuous Skill Teaching Machines"

Tuesday, December 8

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, S W 1), at 9 45 a m —Symposium on "Cyclical Activity in Endocrine Systems"

Society of Chemical Industry, Agriculture Group (at 14 Belgrave Square, London, S W 1), at 10 30 a m —Dr T H Rose and Mr P H Brown "Experiments Comparing a Number of Conditions for the Improvement of Glasshouse Soils", Mr J Webber and Mr F W Shepherd "Experiments Comparing Bulky Organic Manures for Horticultural Crops", Dr F Haworth "Fertilizer Responses of some Vegetable Crops"

Institute of Marine Engineers (at the Memorial Building, 76 Mark Lane, London, E C 3), at 5 30 p m —Mr A Lindén "Recent Development of the Gotaverken Engine"

University of London (at Queen Mary College, Mile End Road, London, E 1), at 5 30 p m —Dr M Eigen (Max-Planck-Institut fur Physikalische Chemie, Gottingen) "Proton-conducting H-bond Systems and their Analogies to Electronic Semiconductors" *

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 5 30 p.m —Dr L G Lajtha "Autoradiography in Bone Marrow Studies" (Fourteenth of fifteen lectures on "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation *) (Further lecture on December 10)

Royal Aeronautical Society (at 4 Hamilton Place, London, W 1), at 7 p m —Dr E K Armstrong and Mr R E Stevenson "Some Practical Aspects of Compressor Blade Vibration"

Wednesday, December 9

University of London (at the Postgraduate Medical School of London, Ducane Road, London, W 12), at 2 p m —Dr J D N Nabarro "Laboratory Investigations in Endocrinology" *

Institute of Physics (at 47 Belgrave Square, London, S W 1), at 6 p m —Sir Edward C Bullard, F R S "Geological Time"

Society for Psychical Reesarch (at Leighton House, 12 Holland Park Road, London, W 14), at 6 30 p m —Dr Letitia Fairfield "Children and Witchcraft"

Oil and Colour Chemists' Association, London Section (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W 1), at 7 p m —Dr S H Bell "Electron Microscopy and Paint Technology"

Society for Analytical Chemistry, Biological Methods Group (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 7 p m —Annual General Meeting, followed by Dr H J Wallis, Mr S. S Kind and Dr A S Curry "Biological Methods in Forensic Science"

Women's Engineering Society (at "Hope House", 45 Great Peter Street, London, S W 1), at 7 p m —Dr Elizabeth Laverick "Radar and Telecommunications Research and Development"

Chemical Society (at Burlington House, Piccadilly, London, W 1), at 7 30 p m —Prof G H Cady "Some Recent Advances in Fluorocarbon Chemistry"

Wednesday, December 9–Friday, December 11

Crop Protection and Pest Control Exhibition (organized by *World Crops*, at the Seymour Hall, Seymour Place, London, W 1)

Thursday, December 10

Institution of Electrical Engineers, Utilization Section (at Savoy Place, London, W C 2), at 5 30 p m —Mr D B Corbyn and Mr N L Potter "The Characteristics and Protection of Semiconductor Rectifiers"

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 5 30 p m —Dr Sheila T Callender, "Iron Absorption" * (Last of the fifteen lectures on "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation)

Thursday, December 10–Friday, December 11

British Institute of Radiology, incorporated with the Rontgen Society (at Church House, Westminster, London, S W 1)—Annual Congress and Exhibition

Royal Society (at Burlington House, Piccadilly, London, W 1), at 9 30 a m daily—Discussion on "The Biology of the Southern Cold Temperate Zone" opened by Prof C F A Pantin, F R S

Friday, December 11

Royal Aeronautical Society (at the Institution of Mechanical Engineers Birdcage Walk, Westminster, London, S W 1) —Symposium on "Flight Safety" (All Day Discussion)

University of London (at the Postgraduate Medical School of London, Ducane Road, London, W 12), at 4 p m —Prof A Haddow, F R S 'The Present and Future Relationship of Cancer Research to Medicine"

Institute of Physics (at 47 Belgrave Square, London, S W 1), at 6 p m —Mr J F Sayers "The Ultrasonic Camera—an Alternative Approach to Ultrasonic Testing"

Institution of Electrical Engineers, London Graduate and Student Section (at Savoy Place, London, W C 2), at 6 30 p m —Sir Willis Jackson, F R S "The Trends of Electrical Progress and Their Implications"

Royal Aeronautical Society, Agricultural Aviation Group (at 4 Hamilton Place, London, W 1), at 7 p m —Mr Peter King "Aerial Operations Planning in the United Kingdom —Results and Difficulties"

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m —Prof R E D Bishop "The Menace of Vibration in Engineering"

Saturday, December 12

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S E 23), at 3 30 p m —Mr Philip Hunter-Jones "The Desert Locust" *

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturer in Mathematics in St Salvator's College—Joint Clerk to the University Court, College Gate, St Andrews (December 31)

Lecturer (with a special knowledge of, and an interest in, the vertebrates) in Zoology—The Registrar, King's College (University of Durham), Newcastle-upon-Tyne 1 (December 31)

Librarian (graduate, with a recognized library qualification, and preferably experience in a University, College or Technical Library)—The Principal, Coventry Technical College, Butts, Coventry (December 31)

Senior Lecturer (with a degree in chemical engineering or applied and industrial chemistry or with experience in the practice of chemical engineering in industry and/or in teaching and research) in Chemical Engineering at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (South Africa, December 31)

Technician (preferably with experience in a laboratory concerned with physiology, biochemistry, or the culture of micro-organisms) in the Botany Department, University of Canterbury, New Zealand —The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (December 31)

Senior Lecturer (with main interest and special qualifications in the field of petrology) in Geology at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, January 4)

Lecturer in Veterinary Anatomy at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, February 27)

Head (graduate, with extensive experience of seed production, preferably including practical farming) of the Multiplication Branch—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge

Qualified Technician (with the Diploma in Chemical Pathology Technique) at Launceston General Hospital, Tasmania—The Agent General to Tasmania, 457 Strand, London, W C 2

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO , LTD ,
ST MARTIN'S STREET, LONDON, W C 2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare London

Annual subscription £7/15/–, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
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Telephone Number Holborn 4743

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UNDER-DEVELOPED TERRITORIES AND THEIR PROBLEMS

IN his presidential address to the British Association in Dublin in 1957, Prof P M S Blackett directed attention to the steadily widening gap between the Western countries and those of Asia and Africa, and advocated a loan of £1,000 million a year, in addition to commercial and short-term government lending either as a free gift or as long-term loans Britain's share of this would have amounted to £150 million a year Although the problem of aid to the under-developed countries has since been widely discussed in all its aspects, it was admitted by the Secretary of State for Foreign Affairs, Mr. Selwyn Lloyd, in a broadcast on United Nations Day (October 24), that the rapid rise in the standard of living in the highly developed countries is not being matched by improvements in those less developed For that reason, he said, the Government will support the work of the United Nations Special Fund to finance large-scale schemes of economic development in such countries, and Parliamentary approval is to be sought to increase five-fold the British contribution to that fund—a contribution at present standing at a million dollars

It should be noted that Mr P Hoffman, director of the Special Fund, has already proposed that the objective should be to double the increase of income a head in the under-developed countries during the next ten years On the calculations of a report of M. J Monnet's Action Committee for the United States of Europe, which called on the Common Market countries to adopt a common policy on economic aid to such countries, this would require doubling the amount of capital supplied to the under-developed countries by the outside world, and the figure of 7,500 million dollars annually is about equivalent to 1 per cent of the combined national income of the richer countries—rather less than the proportion represented by the United Kingdom's estimated total contribution to the development of these countries in 1958–59 of £2 15 million It should, of course, be remembered that, apart from assistance given under the Colombo Plan and under the Colonial Development and Welfare Acts, Britain is contributing in various ways to economic and technical assistance, and in its development fund for overseas territories, the European Economic Community has launched a programme of capital investment in French and Belgian African territories, while, besides its existing massive contribution of some 16,000 million dollars, the United States is being urged by the Senate Foreign Relations Committee to consider a more generous policy to Africa based on the human need to raise standards of living.

One of the biggest obstacles here is the rapid increase in population in those countries, and although the York meeting of the British Association did not give anything like as much attention to the under-developed countries as was done at Dublin, Dr L Harrison Matthews's forthright assertion attracted wide attention In his presidential address to Section D (Zoology), Dr Harrison Matthews declared that the most serious problem at present facing the human race is the frightening rate of increase of population, especially in the so-called under-developed parts of the world. Past and present experience, he said, gives no grounds for complacency, there will be no room to produce food, or indeed anything else, far less to conserve fauna, if there is one person on every square yard

This stern warning that uncontrolled increase in population inevitably builds up to a crash, which incidentally included a strong plea that we should welcome any offer of co-operation from the United States in conservation and like matters in Africa and elsewhere, has been strongly supported in a Friday Evening Discourse which Sir Norman Kipping, director-general of the Federation of British Industries, delivered at the Royal Institution on October 23 Sir Norman believes that one of the two hopes for a real advance in the material standards of the under-developed world lies in a simple, cheap and fool-proof method of birth control, which will give India, Egypt and China a breathing space for their output to catch up and run ahead of their expanding populations His other major hope lies in the development of cheap and simple 1,000 kVa nuclear-fuelled power stations Cheap and plentiful power means, among many other things, he pointed out, water which would be pumped and piped from as far as necessary or distilled from the sea.

Sir Norman showed himself much more aware than many speakers on this subject of the magnitude of the effort which the United Kingdom is already making · in personal terms, we are spending on technical assistance annually about 17*s* 8*d* a head, and, including private investment, which accounts for about half, our total contribution to the development of the under-developed countries is already rather more than 1 per cent of our gross national product Even against the 4,500 million dollars of outstanding loans at the World Bank, external assistance to the under-developed Colombo Plan countries in 1957–58 of more than 1,000 million dollars and United Nations Technical Assistance Administration expenditure of some 30 million dollars a year, this contribution is not to be disparaged, but it is right that Britain and other countries should ask themselves, as Sir Norman suggests, whether in scale or urgency such efforts measure up to the task, whether the full significance of the time factor is appreciated, and whether techniques could be improved The time factor, he recognizes, involves a dilemma, for many of the surest lines of advance involve long-term policies, and he admits that a policy of gradualness is a hard doctrine for many under-developed countries to appreciate

Much that Sir Norman said has frequently been emphasized in other connexions, for example, notably at the Commonwealth Trade and Economic Conference at Montreal in September 1958, though Sir Norman was concerned more particularly to indicate ways in which industry could render practical help. On one point, he strongly supported the views expressed recently by Mr. M. Ionides before the Royal Institute of International Affairs. Mr. Ionides had argued that Western institutions adapted to societies where the initiative comes from below cannot fully satisfy the needs of a society where the flow of initiative is from the top down. In particular, Western institutions are not organized to tap the immense capital resources in these countries already existing in the form of unused man-power. They can only touch the fringe where a cash economy exists. Frequently, by injecting the large-scale projects, we divert available enterprise and initiative from the much-needed widespread small-scale development, and without providing the means for this basic development. The large-scale project does not even teach the simple methods, or provide the required training in them, or, where it is needed, the organizing ability essential for a start.

Sir Norman Kipping elaborated this factor from a different angle, but was no less emphatic that the impetus must come from above—from the élite few in each country who are in contact with the outside world and have educated themselves in modern techniques, and from those from more advanced countries who have come to trade, to teach or to investigate. By and large, in these countries the springs of individual initiative and resource in economic matters have been lacking, and where there is a new awakening and determination the transition into the modern world is harder and more complicated than it was when European development began. This in itself largely accounts, as Sir Norman remarked, for the tendency to think in terms of the grandiose scheme at the expense of the equally important little schemes. It creates the further problem that the educated few tend, by the very fact of their education, to be cut off from the mass of their own people.

This is an aspect to be remembered in considering the functions and future of the Colonial Development Corporation. It is exactly in such a situation that new institutions are needed, new links with institutions in the more advanced countries, and, generally, a flexible and experimental approach. By its nature, the Corporation has always occupied a position between commercial enterprise and public works financed by taxation. It was enjoined, moreover, to have particular regard for the interests of the inhabitants of the countries in which it worked and not merely to pay its way.

The intertwining of social and commercial ends is naturally liable to cause difficulties and, while under Lord Reith's chairmanship much was done to bring the Corporation's affairs into good shape, in his last two years of office conflicts have arisen over policy and procedure, so much so that Lord Reith complained of frustration, and welcomed the establishment, in April 1959, of an independent investigation into the capital structure of the Corporation under the chairmanship of Lord Sinclair of Cleeve. The Committee interpreted its terms of reference—"to examine the functions of the Colonial Development Corporation within its existing statutory framework, and to consider whether any change in its financial structure is required, and to make recommendations"—as requiring it to determine whether or not the existing financial structure is suited to the fulfilment of the obligations laid upon the Corporation, and, if not, to show why and to state how it could be improved. Accordingly, the Committee began by examining the existing functions of the Corporation in the context of the changing circumstances in which more government funds are being made available both under the Colonial Development and Welfare Acts to the decreasing area of the Colonies, and by means of Commonwealth Assistance loans under the Export Guarantees Act, 1949 and 1957, to the former Colonies but now independent territories.

The wider interest of the Committee's report* arises from this preliminary examination, which appears thoroughly to justify Lord Reith's protests. The territorial scope of the Corporation's activities is diminishing, and particularly in territories which by reason of their stage of economic development would have offered more immediate scope for the Corporation's activities. The Committee unhesitatingly concludes that it is not possible for the Corporation to continue to carry out the purposes for which it was set up, and at the same time meet the obligations laid upon it under the Act, unless there is an immediate change either in its financial structure or in the nature of its activities. If it is desired that the Corporation should carry its existing commitments and, still more, should continue to invest in projects involving a considerable degree of risk, the existing financial structure must be amended to one more compatible with the nature of the Corporation's operations, and the Committee's financial recommendations are to that end.

The detailed recommendations need not be considered here, but it should be noted that although the Sinclair Committee believes that its recommendations will both ensure that the Corporation's true financial position will be more easily deducible from the accounts from year to year, and also help to prevent what would otherwise become an intolerable burden undermining the good the Corporation has done or could do, it points out that no modifications to the financial structure can by themselves transmute what is clearly a very difficult operation into an easy or highly successful one. Parliament must be clear as to what exactly the Colonial Development Corporation is intended to do. But the Sinclair Committee finds the claim valid that the Corporation is unique and essentially distinct from nationalized industries and public corporations

* Report of the Committee of Enquiry into the Financial Structure of the Colonial Development Corporation. Pp. iii+25. (Cmnd. 786.) (London: H.M. Stationery Office, 1959.) 1*s*. 6*d*. net.

operating in Great Britain. These are matters rather for the Corporation itself and the Colonial Office, but the Committee leaves no room for doubt that if Parliament wishes the Corporation to continue its efforts to assist economic development in the Colonial Territories, the ordinary rules for payment of interest and repayment of capital must be relaxed; otherwise the Corporation will ultimately be confronted with an annual obligation which it has no reasonable prospect of being able to meet.

The Sinclair Report should thus clarify thinking about both the Colonial Development Corporation and the British contribution to economic development overseas. Specifically, the Committee considers that the Corporation, under the existing Act, should be relieved of liability for interest unpaid at the date when abandonment of a project is approved, and that it should be left to the commercial judgment of the Corporation to decide when to realize on investment, bearing in mind that once a project has become firmly established and is benefiting the economy of the territory concerned, the primary purpose of the Corporation in initiating the project has been achieved. Later, the Committee reiterates the view that the question of accountability as affecting the Corporation is not in practice capable of sharp definition, and suggests that broadly the judgment whether a project is worth while on commercial grounds is primarily one for the Corporation, and the decision whether it is in accord with public policy and within the Act is for the Secretary of State.

In such circumstances it is the more important that questions of Colonial development and welfare and of assistance, whether economic or technical, to the under-developed areas generally should be discussed as free from party political prejudice as possible. The problems are too complex and difficult to be capable of easy solution even when all the facts can be ascertained beyond question. What matters is that discussion should be fully informed, and as free as possible from prejudice, and that programmes of action should be framed to take account of the social and educational difficulties, as well as those of technology, economics and finance. It is obvious that much preparation will be required, even when such discoveries or developments as those for which Sir Norman Kipping pleaded have taken place, before their results can be made available to the under-developed areas. Meanwhile, the more clearly the situation is understood, both in the advanced and the backward areas, and the more resolutely and urgently the United Kingdom and other advanced countries contribute towards meeting existing needs and filling available opportunities, the easier it should be to take full advantage of any fresh advance which will enable mankind to solve this threatening problem of unbalance between population and all its myriad needs and the material resources in food, in fuel, in energy and mineral wealth to satisfy them. Sir Oliver Franks remarked early this year that the under-developed countries cannot be free to embark upon development programmes regardless of their own resources, and then expect the industrial countries to underwrite them to an unlimited extent; and, on the other hand, for the developing countries to have any chance of raising their standards of living they must undertake capital development on a scale which is bound to make their demand for imports outstrip their ability to pay in exports for many years to come, quite apart from the population question. There, however, lies the real problem, and if the gap in living standards is to be closed and all its explosive possibilities removed, both understanding and a sense of urgency will be needed; the situation requires human sympathy as well as economic insight and the wise use of all instruments that come to hand.

NUMBERS OF PEOPLE

The Study of Population

An Inventory and Appraisal. Edited by Philip M. Hauser and Otis Dudley Duncan. Pp. xvi+864. (Chicago: University of Chicago Press; London: Cambridge University Press, 1959.) 112*s*. 6*d*. net.

THE counting of people is almost as old as man himself. Concern about numbers is old but not so old. The study of population as a narrow field of formal scientific inquiry goes back only three centuries. The recognition of the interdisciplinary character of the more embracing study of population in relation to space and resources is recent and not yet sufficiently widespread. An account of historical development linked with and supporting both a contemporary assessment of the status of demography as a science and an evaluation of the possibilities of its integration with other scientific disciplines has been needed for some considerable time. This need has now been met. Such a project is a formidable undertaking and the size of the resultant volume is also formidable. One wonders whether it was necessary to have separate chapters on the development of demography in different countries except as a concession to national pride. It would have been better to have a world review of significant developments shown in relation to the social and economic pressures which stimulated them. The editors, too, have spread themselves unduly in the introductory chapters. But it is all interesting and well written; and more ruthless editing would not have made the book much lighter.

Undoubtedly the general pattern of the book is right: four chapters on demography as a science; nine chapters covering historical development on a world-wide scale; twelve chapters on different sub-fields in demography; seven chapters on population studies in various disciplines (genetics, human ecology, sociology, anthropology, economics, geography); and, surely a blessing in so large a volume, the 'overflow and conclusions' form the subject of Chapter 1. The historical chapters make fascinating reading. The authors have succeeded in bringing to life the significant personalities and the raging controversies (of which the Malthusian is but one) of earlier days. The treatment of British demography by Prof. E. Grebenik is balanced and fair. It is sadly true that while considerable developments of technique were made by actuaries throughout the nineteenth century, formal teaching in British universities has lagged. This is mainly due to the lack of career outlets for demographers, the incentive to specialize being correspondingly small Perhaps, however, there should be less specialization In those vast areas of the world where population growth presses so menacingly upon under-developed economies, pure demographers are less in demand than those with a wider and multidisciplined approach, an understanding of the subtle inter-relationships between demographic, geographical, ecological, social and economic factors Just how wide the field of knowledge must be is excellently illustrated in the closing chapters of this symposium Everywhere knowledge is incomplete Information concerning land and other resources, the effect of locational factors, genetic changes and biological influences, cultural forces, and the manner of community expansion and reorganization—all this now concerns the population student

If any part of the book is to be criticized, it is the form and content of the middle chapters This is not a question of factual or expository deficiency, for authorship is of a very high standard One gets the impression of a little too much erudition, particularly too much factual content, and not enough concentration upon methods of measurement The chapter on population distribution criticizes the descriptive and one-sided character of contemporary studies, but appears to favour methods of multiple regression analysis which succeed only to the extent that they are descriptive, and are in disrepute because they have built-in hazards of interpretation It ignores the volumetric approach of the geographer The fertility chapter affords little space to the index problem in measurement and concentrates more on the subject of fertility regulation ; on the other hand, the chapter on population replacement is largely confined to methods of arithmetic with barely enough interpretative caution But it must be admitted that it is always difficult to decide how much space to allot to explaining how to measure and how much to discussing the essential character of the events that are being measured The book is claimed to be an encyclopædic summary It is a difficult feat of editorship to prevent this from being a contradiction in terms and the editors are to be congratulated on a very high measure of success This is more than a reference book , it will attract sustained study

B Benjamin

STERIC EFFECTS IN ORGANIC MOLECULES

Steric Effects in Conjugated Systems

Proceedings of a Symposium held at the University, Hull, 15–17 July, 1958, by the Chemical Society Edited by Dr G W Gray Pp viii+181 (London Butterworths Scientific Publications , New York Academic Press, Inc , 1958) 30*s*

THIS relatively inexpensive book is a useful addition to the small number of books concerned with steric effects in organic molecules It contains the fifteen original papers, together with 44 pages of ensuing discussion, which were read at the symposium held in Hull during July 15–17, 1958

A lucid historical survey by E E Turner was followed by seven papers in which the relationship between the light absorption and the conformation of conjugated systems was discussed The theoretical treatments of C A Coulson and of W F Forbes were accompanied by papers by G H Beaven, C C Barker, and by E S Waight and R L Erskine, incorporating detailed measurements of the spectra of numerous alkyl diphenyls, di- and tri-phenylmethane dyes, and conjugated carbonyl compounds, respectively Certain spectral data were related to rates of reaction and the pK_a by B M Wepster, though the author pointed out that this approach is not universally applicable

Attempts to evaluate steric and electronic effects with the aid of kinetic data were described in four papers The rates of nucleophilic aromatic substitution, of the solvolysis of aralkyl halides, of the acid-catalysed H–D exchange in aromatic hydrocarbons, and of a variety of reactions involving *ortho*-substituted compounds were discussed, respectively, by N B Chapman, H C Brown, G Dallinga *et al* , and A C Farthing and B Nam

The remaining papers illustrated the application of other physical methods A paper by E A Johnson on the gas-liquid chromatography of alkyldiphenyls provided an interesting complement to that by Beaven Contributions by J W Smith and by G W Gray described dipole moment measurements and observations on mesomorphism, respectively

In summary, this collection of original papers embodying review material and some discussion provides a valuable survey of contemporary studies concerning the conformations of conjugated molecules.

G Eglinton

COLORIMETRY

Colorimetric Methods of Analysis, including Photometric Methods

Vol 2A By Dr Foster Dee Snell and Dr Cornelia T Snell, assisted by Dr Chester Arthur Snell Pp x+793 (New York D Van Nostrand Company, Inc , London D Van Nostrand Company, Ltd , 1959) 112*s* 6*d*

THE volume under review supplements the data given in the third edition (1948–54) of Volume 2, and includes all the important publications which have appeared prior to January 1956 In dealing with such a vast compilation, now five volumes, the authors cannot from their personal experience recommend any particular method, and the question arises as to whether treatises such as this have a universally useful function The answer appears to be that this treatise has been compiled by a team of experienced abstractors who can consult their own analytical department, and who are thus well able to judge whether a method merits recording or not

The scheme adopted throughout the volume is both logical and helpful to the reader Each chapter is headed by a brief description of new and useful additions to the methods described in the previous edition of Volume 2 Where the method is the result of collaborative study by a number of laboratories it is frequently given almost in full Thus the reader can proceed with such a method in confidence, knowing that it has been tested in a number of independent laboratories, and has justified its publication by a representative body of experts While this results in recording methods which have proved sound, these methods may not be the best available even shortly after publication, since collaborative studies between widely separated laboratories are necessarily very time consuming

One of the most useful new features in the volume is the prominence given to the use of flame photometry and fluorimetry. As stated in the preface, the improvements in burners and the application of photomultiplier tubes have greatly increased the sensitivity of the flame photometer, and improved tubes that of the fluorimeter. It would have been helpful if the general principles of the improved methods both for flame photometry and fluorimetry could have been described as a separate chapter, but presumably these will follow in a supplement to Volume 1. Without such help it may be puzzling to understand why on page 471 an oxy-acetylene burner is recommended for the determination of the alkali metals, but a propane-air burner on page 475. Much depends on the concentration of interfering elements and on the choice of internal standards. While such standards are desirable, their use may be attended by difficulties, since the optimum burner temperature for development of the colour of the test element may be far removed from that of the standard. What is required is not merely high sensitivity, but also uniform light emission with varying temperature. As a useful alternative to flame photometry for the determination of lithium, the application of fluorimetry is described, the sensitivity being such as to make as little as 0·005 mgm. determinable in the presence of limited amounts of sodium and potassium.

The amount of new material described in Volume 2A is astonishing, bearing in mind the short interval of time which has elapsed since the publication of Volume 2, and the original treatise of four volumes cannot be considered complete without Volume 2A. The references have been carefully chosen from an extremely wide selection of the world's scientific journals, and unlike some U.S.A. publications have no bias in favour of American work. J. KING

STATISTICAL METHODS

Principles of Statistical Techniques

A First Course, from the Beginnings, for Schools and Universities. By P. G. Moore. Pp. viii+239. (Cambridge: At the University Press, 1958.) 22s. 6d. net.

IN the Preface to this excellent text-book the author claims that it is "... an attempt to put across the main principles of statistical methods ...". This claim is abundantly justified. The book is readable from start to finish, and only in Chapters 10 and 11 (dealing with tests of significance) will more than normal concentration be needed, even if the reader is approaching the subject for the first time. The book will be a valuable addition to every grammar-school library. Many sixth form pupils, especially those reading geography or economics, will derive great benefit from a careful study of it; in the field of general studies, however, it will appeal to a much wider audience so that merely a single reading will help towards a clear understanding of the part which observation and sampling now play in pure research and in industrial investigations.

The author's style is attractive and the reader is led easily through chapters on the collection, tabulation and representation of data, frequency distribution and dispersion, to a careful study of the power (and the weaknesses) of sampling. The application of the binomial series and time series, together with a rather more technical consideration of significance, bring the student to a treatment of regression. The printing, tabulation and graphs have the excellence normally associated with the Cambridge University Press and there are few misprints. Important among these is the misuse of $\sqrt{npq}$ for $\sqrt{(npq)}$ in a number of places, and the same error is found (p. 160) in the formula

$$s=\sqrt{\frac{1}{n}}\Sigma(x-\bar{x})^2$$

At the end of each chapter there is a good set of exercises, but the value of these is greatly reduced by the absence of answers. It is to be hoped that the author will remedy this by a pamphlet until another edition is available. With this one serious reservation the book may be recommended warmly to anyone who needs to know, either for practical purposes or as a matter of general interest, how the analysis of observations can be accomplished. W. J. LANGFORD

PERCEPTION AND LEARNING

Dynamics of Behavior

By Prof. Robert S. Woodworth. Pp. x+403. (London: Methuen and Co., Ltd., 1958.) 36s. net.

PROF. WOODWORTH began his scientific career some sixty years ago with an admirable little book on movement, written in French. He afterwards worked with Sherrington on pseudo-affective reflexes and seemed well set to develop American psychology along experimental and physiological lines. Yet leadership in research somehow eluded him. The initiative passed to others, in particular Lashley, and it was left to Prof. Woodworth to provide the text-books on which successive generations of psychology students in the United States have been nourished. Plain fare, perhaps, but wholesome.

The present volume has its origin in the author's "Dynamic Psychology", first published in 1918. But it is far less a revision of the earlier book than the substance of a lecture course based upon it and progressively developed by Prof. Woodworth over the past forty years. The content ranges from reflexes to reasoning, the greater part being concerned with perception, motivation and learning conceived in terms of biological adaptation. Although the eclectic point of view will be familiar to readers of Prof. Woodworth's earlier texts, the present volume has the advantage of bringing together a great deal of experimental material, much of it recent, relevant to the general analysis of behaviour. It also provides a useful guide to the many, and often conflicting, theories of learning which have been evolved by American psychologists during the past thirty years. This is the kind of thing which he can do very well.

Prof. Woodworth demonstrates that his capacity to expound contemporary points of view in psychology has been in no way dimmed by advancing age. At the same time, his account of modern work perhaps suffers from the lack of any well-defined point of view of his own. Had the author held fast to his Sherringtonian origins and attempted to develop a theory of behaviour along evolutionary and physiological lines, it is possible that some real clarification might have been achieved. As it is, we have to make do with a somewhat ill-assorted conglomeration of facts and theories, imperfectly related one to the other, and the whole scarcely warranting treatment as a scientific discipline. Although it may be objected that this picture truly reflects the existing state of psychology, it might seem a pity to enshrine it in a formal text.

A contribution more limited in scope, tauter and more incisive in argument, would have served the purpose better

The author's style betrays a certain trans-Atlantic homeliness that may cause some elevation of English eyebrows Thus the reader is urged to "get acquainted with gravitation" much in the same way as he might be advised in other quarters to make friends and influence people It may also be surmised that the prevailing emphasis upon "outgoing human tendencies" owes more to American culture than to the scientific study of man

It is encouraging to note that Prof Woodworth retains something of his interest in the European scene Although ethology appears to have escaped him, British work in experimental psychology is exceptionally well represented O L ZANGWILL

NUCLEAR ENERGY AND ANALYSIS

Analytical Chemistry

Vol 1 Edited by M T Kelley (Progress in Nuclear Energy, Series 9) Pp vi+372+xii (London and New York Pergamon Press, 1959) 105*s* net

THIS volume consists of a collection of some of the papers of interest to analytical chemists which were presented at the Second International Conference on the Peaceful Uses of Atomic Energy held at Geneva in 1958 These papers have already been made available in Vols 3, 19 and 28 of the records of the Conference published by the United Nations, and this new book simply presents the material in a single volume of a more convenient size The papers have been arranged in five groups as follows: "Reactor Applications", "Activation Analysis", "Spectrographic Technique", "Industrial Applications", and "Health Physics" All papers are in English with the exception of two which are in French The reason for not publishing a complete volume in English is not clear, especially since these two papers are available in English in the United Nations publications

The first group of papers contains one giving the Harwell experiences in analytical chemistry work connected with reactors Two excellent review papers are also included, one dealing with most aspects of the analytical chemistry of thorium and the other on chemical methods for the determination of uranium in ores and associated materials In the activation analysis section, much information is given about Canadian and United States experiences with this valuable technique for trace determinations, especially when used in conjunction with γ-spectrometry A notable omission from this section is the excellent paper by Smales and co-workers reporting British experiences with this technique; this paper is available in Vol 2 of the United Nations publications

Other papers of note in the remaining sections deal with the use of infra-red spectroscopy for determinations connected with the use of heavy water in atomic energy work, and the use of non-destructive X-ray spectroscopy for the analysis of reactor fuel components Fassel's spectrographic method for the determination of gases in metals is also described In the section on "Industrial Applications", developments in the analytical services given to the programmes of the Industrial Groups of the U K Atomic Energy Authority are described Other papers deal with the use of radioisotopes in Japanese industry and the determination of tungsten in steels by employing the back-scattering of β-particles

The editing of this book could have been better and the index should have been more detailed A price of 5 guineas for a book of this type is very high

G W C MILNER

NORTH AMERICAN MAMMALS

The Mammals of North America

By Prof E Raymond Hall and Dr Keith R Kelson Vol 1 Pp xxx+1–546+79 Vol 2 Pp viii+547–1083+79 (New York The Ronald Press Company, 1959) 35 dollars the set

THE North American continent has a rich mammal fauna (995 species according to this compilation), and it has also a relatively high population density of mammalogists, among whom Prof E Raymond Hall is one of the best known With Dr K R Kelson, he has completed the enormous task of bringing together the most up-to-date facts and opinions about the taxonomy and distribution of North American mammals in an excellent production

The costs of preparing the manuscript, with its 500 maps, 553 figures, and numerous line drawings, must have been high, even by New World standards The completed work is a monument, not only to Prof Hall's ability as a mammalogist, but also to his talent for raising funds from official sources

Prof Hall's attitude to the law of priority in nomenclature is regarded by some people as admirable, and by others as intransigent It is certain that the vast majority of zoologists will regret his following Hershkovitz in calling the Virginian deer *Dama*, in the face of the request by the International Commission on Zoological Nomenclature to 'freeze' the situation pending its decision If the change is accepted (and here we find it in what will be a standard work for generations), it means that the European fallow deer, known to all as *Dama*, must be called *Odocoileus* The Commission will most probably decide to use its plenary powers to preserve stability in this instance Likewise, the Commission is considering the question of the availability of Oken, 1815–16, "Lehrbuch der Naturgeschichte", and Morrison-Scott has asked it to validate, among others, the well-used names *Citellus*, *Vulpes*, *Panthera* and *Pan* Hall and Kelson have rejected Oken while the matter is still, so to speak, *sub judice*, and have made some regrettable changes

One is surprised to find Merriam's 78 species of bears still recognized, but this directs attention to the fact that the authors have not attempted to revise questions of status, but have put forward the views of the most recent workers on a group, even when those views are patently unsound Many changes in taxonomic status will occur, and many subspecies recognized here will disappear, but here they are, all clearly listed, and it is far preferable to summarily dismissing them as synonyms without explanation

Everyone will be able to find something to disagree with in such a large work as this, but on the whole the work will be welcomed by every worker on North American mammals It is essentially for the professional, and outside the United States will have limited sales, but purchase by every university is obligatory For zoologists in other countries the distribution maps alone are worth the price

PETER CROWCROFT

Synthesis of Linear Communication Networks

Vols 1 and 2 By Wilhelm Cauer Second edition edited by Wilhelm Klein and Franz M Pelz Translated from the German by G E Knausenberger (McGraw-Hill Electrical and Electronic Engineering Series) Pp xxxvi+866 (London McGraw-Hill Publishing Company, Ltd, 1958) 151s

THE classical work of W Cauer on network synthesis was first published in 1941 and has only now appeared in an English translation During the fourteen years since the death of Cauer there have been many developments in network theory which have been treated at length in a number of recently-published text-books But Cauer's work cannot be regarded as out of date nor is his book in competition with these modern American texts Rather is it one of those permanent collections of work from which modern theory derives

The first part of the book contains a thorough treatment of one-terminal pair and two-terminal pair networks along lines which have now become familiar The image-parameter network is treated in very great detail and considerable attention given to the design of filters In the second part, Cauer treats reactance networks in general and expands the theory of frequency band-separation networks, a subject neglected in most other works

An attempt is made to bring Cauer's work up to date by the inclusion of a 44-page appendix outlining the recent advances in network theory and presenting a classified bibliography containing about 450 references

Advanced Analytical Chemistry

By Prof Louis Meites and Prof Henry C Thomas With a chapter on Infrared Radiation by Prof Robert P Bauman Pp xi+540 (London McGraw-Hill Publishing Company, Ltd, 1958) 69s

MODERN thought in analytical chemistry centres largely in the field of instrumental or physico-chemical methods, this is reflected in the ever-growing number of text-books dealing with this subject, either alone or as part of a study of 'advanced analytical chemistry'

The present book, written by two authorities in the field of electrochemistry (as applied to analytical chemistry), is basically the outcome of seven years experience in teaching undergraduate and graduate students at Brooklyn Polytechnic and the University of North Carolina On reading this book one can only envy these students their courses of instruction

The book is divided into twelve formal chapters which take the reader from a short but excellent discourse on the nature of analytical chemistry to a similarly well-written account of ionic equilibria in solutions and then to a series of chapters dealing with selected methods of instrumental analysis These include *p*H and redox potentiometry, conductometry, polarography and amperometry, electrolytic methods, spectrophotometry (visible, ultra-violet and infra-red), radiochemistry and finally ion exchange and chromatography This part of the text is concluded by a chapter on the development of an analytical method, this unusual inclusion in a student text is commendable in that it illustrates admirably the nature of analytical chemical research A number of appendixes then interrupt the text and these are followed by a longish (116 pages) section devoted solely to about ninety practical applications of the methods discussed earlier

Unlike many books on this subject, the present one gives prominence to the theory of the methods, although unifying this theory with the practical exercises The instruments themselves are subordinated to the theory underlying their use and it is indeed refreshing to find that the student is taught the essentials of a method so well, often on simple instruments, that when he encounters a more elaborate instrument he can "confidently be referred to the manufacturer's instruction book for information on how to turn the knobs"

Much could be said about this book, but in the end the conclusion would be the same—an excellent book, and well worth study not only by students but also by research workers in analytical chemistry

W I STEPHEN

The Structure and Properties of Porous Materials

Proceedings of the Tenth Symposium of the Colston Research Society held in the University of Bristol, March 24th–March 27th, 1958 Edited by D H Everett and F S Stone Pp xiv+389 (London Butterworths Scientific Publications, New York Academic Press, Inc, 1958) 60s, 12 dollars

THIS is a collection of papers from the tenth Colston Research Symposium held in Bristol last year Its scope may be indicated by listing the authors Rideal, Barrer, Wynne-Jones, Kington, de Boer, Everett, Dacey and Fendley, Flood, Wiggs, Kiselev, Foster and Thorp; Schofield, Mougey, François-Rossetti and Imelik, Kavtaradze, Rance, King, Honeybone and Harris, Preston As the names indicate, the authors' interests range from almost pure physics to biology The verbal discussions are particularly interesting, and show a fair degree of cross-fertilization They have been taken from tape recordings, and the temptation to over-edit has been avoided A few staccato exchanges read like verbatim reports of cross-examination, and the flavour of the individual contributions has been retained The reviewer approves of this, though he can conceive that this approval will not be universally shared

Demographic Yearbook 1958

(Special Topic Marriage and Divorce Statistics) Pp viii+541 (New York United Nations, London H M Stationery Office, 1958) Cloth, 8 dollars, 57s, 34 Swiss francs Paper, 6 50 dollars, 46s, 28 Swiss francs

THE "Demographic Yearbook" of the United Nations continues to provide the basic data for the population of the world The 1958 issue which has recently been published shows the annual rate of increase of the world's population over the period 1950–57 to be sixteen per thousand Central America, with a rate of twenty-six per thousand, is increasing fastest, North-West Europe, with a rate of six per thousand, shows the slowest rate of increase Figures of births, deaths, birth-rates, death-rates and expectations of life are again included, but the special topic dealt with in this issue is the statistics of marriage and divorce Data on marriages, the ages of persons married, singly and in combination, and marriage- and divorce-rates are given for the various countries There is also an introductory chapter in which the uses of nuptiality statistics are discussed

The volume continues the standard of excellence that one has come to expect from its predecessors

SPIRAL AND OTHER GROWTH FORMS OF SYNTHETIC DIAMONDS: A DISTINCTION BETWEEN NATURAL AND SYNTHETIC DIAMOND

By PROF S TOLANSKY, F.R.S, and DR I SUNAGAWA
Royal Holloway College, University of London

IN our laboratory, we have, during the past fifteen years, examined the surface microstructures of many hundreds of fine natural diamonds, mainly octahedra and dodecahedra, using precision optical techniques In view of the importance of the screw dislocation theory of crystal growth, we have sought diligently for spirals on these diamonds but we have never yet found a single indication of the existence of a spiral on any of the several thousand faces examined Nor, so far as we know, has anyone else Our techniques are sufficiently sensitive to reveal spiral growth sheets of height even less than 10 A We find with natural crystals that octahedral faces invariably exhibit growth trigons, dodecahedral faces show striations, networks or elevated disks and cubic faces are extremely rough We are quite categorical about never yet having found a growth spiral on diamond, indeed, the only near resemblance to such was experimentally identified as a percussion mark, simulating in its crack directions a crude resemblance to a spiral

We have recently acquired some specimens of the micro-diamonds made synthetically by the General Electric Company of Schenectady, some kindly loaned by Dame Kathleen Lonsdale, of University College, London, and some by Dr Custers of Johannesburg These are being subjected to a detailed examination, using both interferometry and a particularly sensitive phase-contrast microscope, from Japan, which is at our disposal The new characteristics we describe here are shown by both samples They have not been reported before in the very extensive literature on natural diamonds We describe here three new characteristics shown by these synthetic diamonds

(1) There are occasional cubic faces on the synthetic diamonds which have a highly perfect smooth optical finish Fig 1 (× 480) shows such a cubic face photographed with the sensitive phase-contrast microscope It should be mentioned that this microscope has successfully revealed steps on other crystals which we have established interferometrically to be as small as some 2 5 A It follows, therefore, that the relative uniformity of the phase-contrast picture is evidence of an exceptionally smooth flat perfection of surface, a perfection locally approaching uniformity of the order of lattice dimensions Such smooth perfection on cubic faces is quite unknown on natural diamonds, although we have found such perfection occasionally on one or two highly perfect natural octahedral faces

(2) Quite a number of synthetic diamonds reveal a new form modification They are typical dendrites These dendrite characters we find in two distinct ways On most diamonds they appear as network (dendritic ?) overgrowths (see Fig 2, × 480) Slip effects are also clearly visible We believe the dendritic markings to be diamond since both strong heat and chemical reagents do not affect them However, far more striking is the occasional occurrence of complete dendritic crystals, typical examples of which are shown in Fig 3 (× 75)

In connexion with these dendrites attention is directed to the fact that they most closely resemble in shape some germanium dendritic crystals in our possession, and, of course, it will be recalled that the germanium crystal has the diamond structure

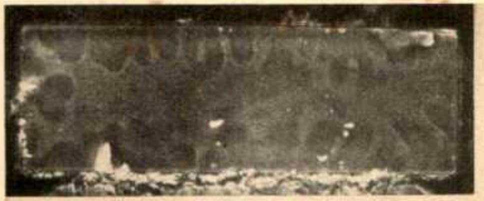
So far as we know, completely dendritic crystals such as we find here in synthetic diamond have never been reported for natural diamond, so that we have a second distinction between the synthetic and the natural crystals

(3) Our most notable observation has been the discovery of several spiral growths on quite a number of the good-quality cubic faces of the synthetics Fig 4 (× 480) shows our finest example, taken with the phase-contrast microscope On the original it can be clearly seen that the spiral arms are kinked, but that the separate components of the kinked arms are rectangular, the units are parallel to the edge between cubic and octahedral faces This establishes that the spiral really does belong to the diamond, for if it were a foreign overgrowth it would be too remote a possibility to find something completely epitaxial in lattice to fit the cubic face of the diamond In any event we cannot remove the spiral and are quite satisfied that it is really diamond

From our familiarity with comparison of our phase-contrast pictures with our multiple-beam interferograms on other crystals we can make a reasonably confident estimate of the step height of the spiral We estimate this to be of the order of some 100 A The quality of the surface between the spirals is very good, and on our originals we see close evidence of a secondary much weaker spiral originating from the same dislocation region

The kinking of the spirals is reminiscent of those we have seen at times on organic crystals and bears no resemblance to the silicon carbide spirals so often recorded in our laboratory Their character is essentially cubic The setting on our phase-contrast instrument tells us that these are true hillock spirals, the centre being the high region, as is to be expected

A number of spirals have been found on different crystals, and it would appear that most of them favour originating near a corner of the cubic face Fig 5 (× 650) is one such corner spiral and Fig 6 (× 650) is another Fig 6 exhibits a further interesting topographical characteristic, in that there are quite clearly shown a number of distinct slip lines crossing the spiral arms



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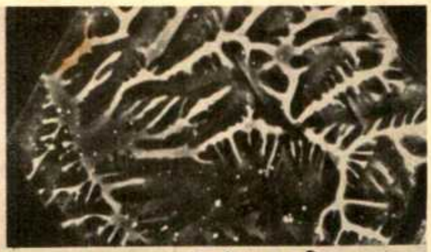

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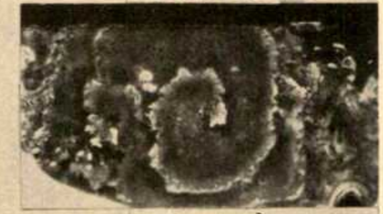

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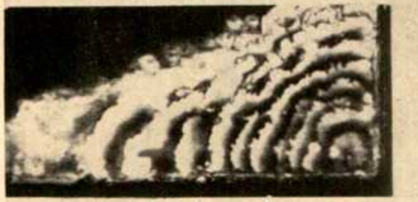

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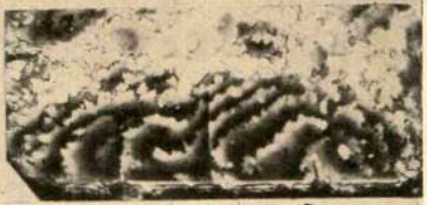

6.(X650)

Two matters appear to call for comment. The first is that these micro-crystals were grown rapidly, which is probably far from the case of the natural diamonds. A second, and perhaps more important, point is that, according to Dame Kathleen Lonsdale, this type of synthetic diamond may have up to even 3 per cent impurity included, in the form of metal carbide. It may well be that the inclusion of so much metal carbide in the lattice is responsible both for the appearance of the dendritic form and also for the appearance of the spiral dislocation, since neither of these features appears in the natural diamond.

Having made these observations, we secured for examination, through the courtesy of Mr. R. G. Mason, of Industrial Distributors (London), Ltd., no less than fifty well-formed natural cubic diamonds. All were Congo boarts, and the idea behind this was that we wished to examine natural cubes which clearly contained impurity too. The colours were greys, browns and blacks. Many of the 300 faces available are hopelessly too rough for precision optical examination, but some of the smaller stones were of reasonable surface quality. We have found no trace either of (*a*) a high-quality surface or (*b*) spirals.

Thus we still confirm the complete absence of any growth spirals on natural diamond faces, whether octahedral, dodecahedral or cubic. We therefore incline strongly to the view that both the spirals and dendrites reported here are due to some special causes distinguishing the synthetic from the natural diamond. This may be either due to different conditions during formation, or alternatively it may be due to metal carbide inclusion.

A VIVIPAROUS DEEP-SEA JELLYFISH

By DR. F. S. RUSSELL, C.B.E., F.R.S.
Marine Biological Association, Plymouth

ON a cruise off Santander, to collect deep-sea animals for Dr. S. K. Kon and Dr. L. R. Fisher, of the Development Commission Fisheries Research Biochemical Unit, R.V. *Sarsia* brought up on October 18, 1959, in a deep haul with the Isaacs Kidd pelagic net (3,300 metres of wire out) a very remarkable jellyfish (Fig. 1).

This is a deep brownish-red and plum-coloured semaeostome scyphomedusa measuring about 50 cm. across the umbrella. It has four simple mouth arms each more than 1 metre in length. It apparently has no tentacles. The stomach is about 25 cm. in diameter and from it issue 17 or 18 straight radial canals alternating with a number of canals joined to form networks and running for 6–7 cm. towards the umbrella margin, after which they all break up peripherally into a much finer anastomosing network. The margin is somewhat damaged but there are indications of a continuous ring canal. There are four inter-radial gonadial pores each 1·5 cm. in diameter.

But the most remarkable feature is that the medusa is viviparous. Each of the four gonads

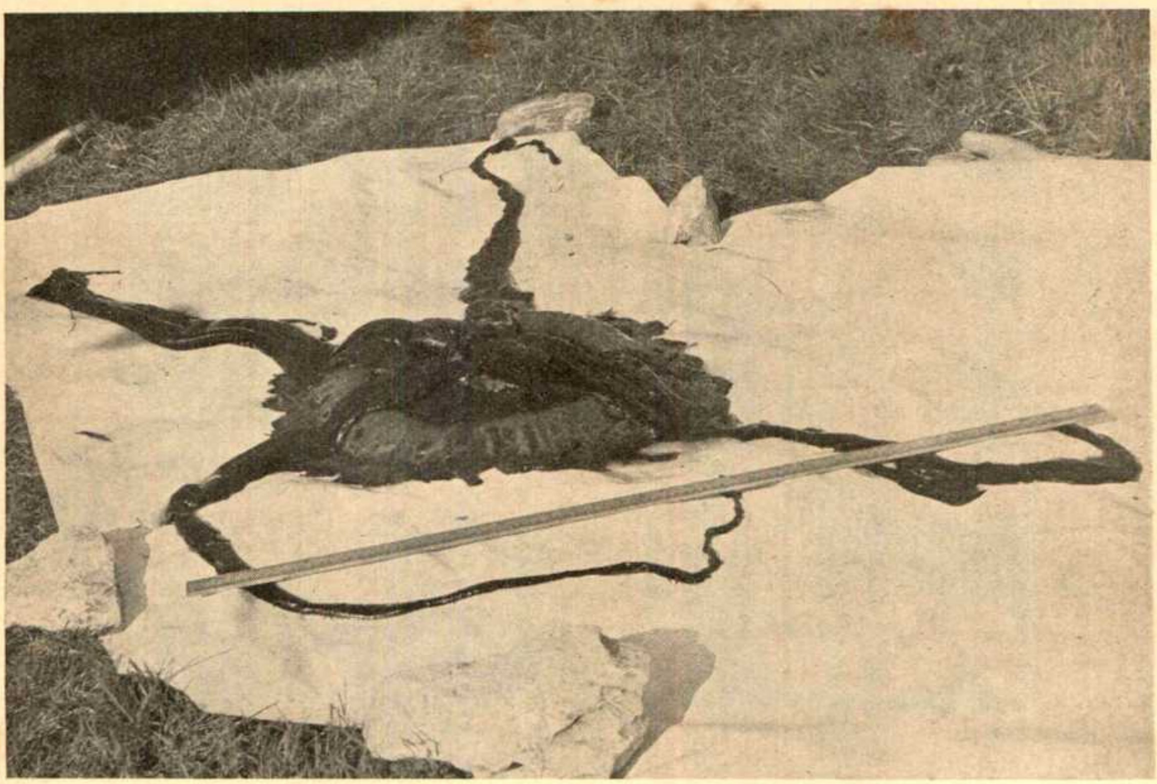

Fig. 1. *Stygiomedusa fabulosa* n.g., n.sp. There is a metre rule in the foreground

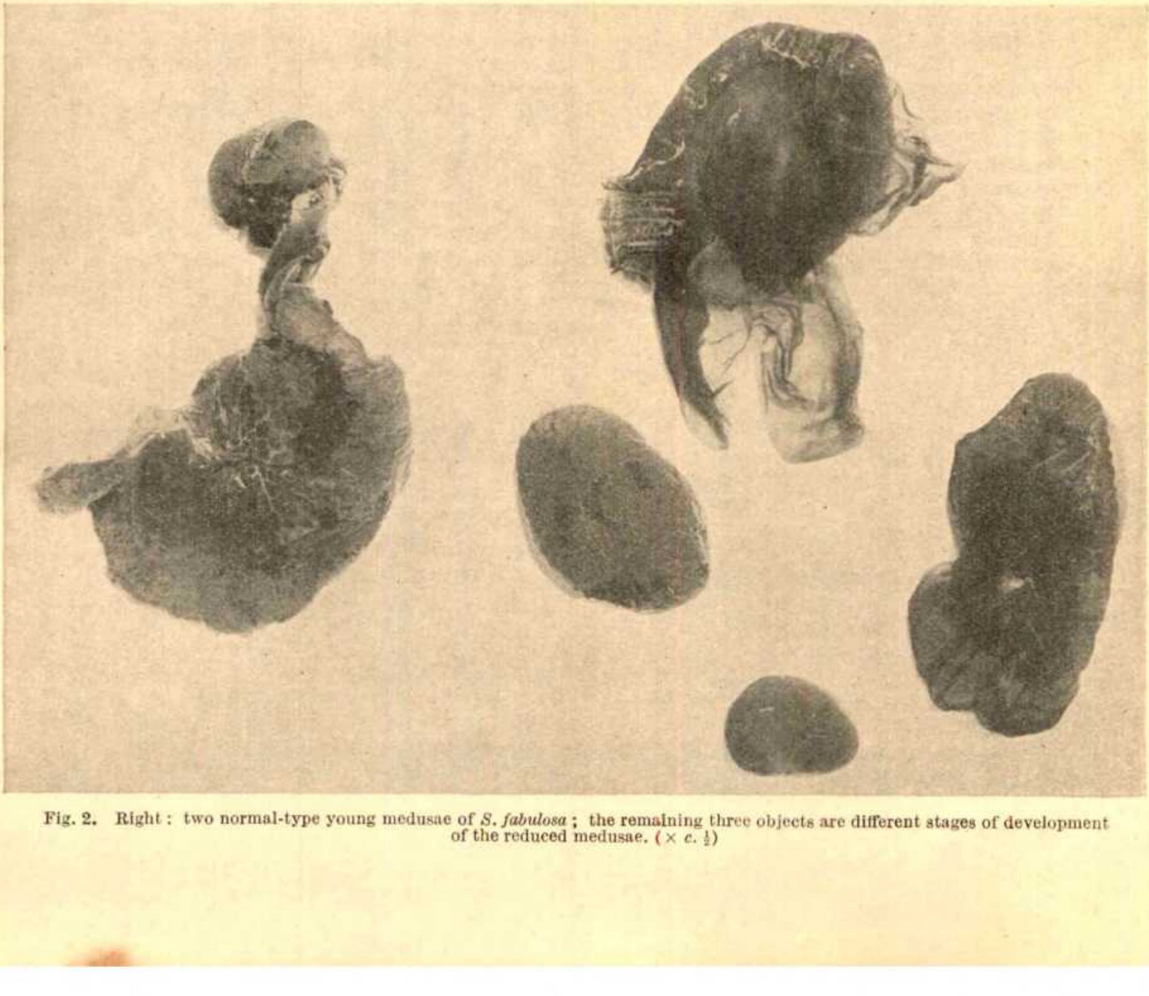

Fig. 2. Right: two normal-type young medusae of *S. fabulosa*; the remaining three objects are different stages of development of the reduced medusae. (× *c*. ½)

bears several white ovoid bodies attached to its wall These are elongated and narrowing sharply distally, and they vary in size from 1 0 cm × 0 5 cm to 5 0 cm × 2 5 cm One still larger, 7 5 cm × 5 0 cm, contains a large developing medusa There are two fully developed young, each about 10 cm in diameter These are perfect except that each has a large hole in the apex of the umbrella, presumably where they were, perhaps prematurely, separated from the stalk They have 20 or 21 marginal sense organs and about sixty marginal lappets Neither has any tentacles and this confirms their absence in the adult The mouth arms are well developed and broad and filamentous The developing gonads are already fully visible There are many canals issuing from the stomach, all forming a very branched network of canals around the periphery as in the adult This network runs into a continuous ring canal round the margin

There are also four objects which I thought at first to be developing young broken away from their stalk Two of these appear as rather featureless lumps of jelly with a honeycombed pattern In one there is the obvious beginning of the development of a lobed umbrella margin and there is one which has developed into a flat disk-like object about 10 mm in diameter (Fig 2, left) This is evidently a reduced medusa, because it has ten marginal sense organs, but no mouth The nature of these bodies must await further examination

There is no doubt that this is an entirely new semaeostome scyphomedusa coming near the Ulmaridae but differing in the absence of tentacles I am naming it *Stygiomedusa fabulosa* n g , n sp , and I hope later to be able to give a more detailed description

The position of capture was approximately lat 44° N , long 3° 45′ W It cannot be said from what depth the specimen actually came, but from its coloration and its habit of viviparity it must certainly normally live at great depths

I would like to thank Capt C A Hoodless and all those on board R V *Sarsia* for the care they took in preserving this specimen and bringing it back safely to the laboratory, and Mrs E A Peace for taking the photographs

CONSERVATION IN THE SCOTTISH HIGHLANDS

A SYMPOSIUM on "Conservation in the Scottish Highlands" was held by the Scottish Branch of the Institute of Biology during September 29 and 30 in Glasgow, followed on October 1 by an excursion to the Black Wood and Moor of Rannoch The following papers were read "Problems of Conservation in the Highlands", by Prof W H Pearsall (Nature Conservancy), "Geology of the Scottish Highlands and Islands", by A C MacGregor (Geological Survey of Great Britain, Edinburgh), "Soil Conditions in the Highland Areas", by R Glentworth (Macaulay Institute for Soil Research, Aberdeen), "Soil Erosion in Scotland", by R M Gorrie (ex-Indian Forest Service, Edinburgh), "The Role of Bracken in Highland Ecology", by Prof K W Braid (Aberdeen), "Scottish Soils in Relation to Afforestation", by W O Binns (Macaulay Institute for Soil Research), "Peat Afforestation", by M V Edwards (Forestry Commission), "The Effect of Conservation Practices on Animal Distribution", by W J Eggeling (Nature Conservancy), and "Conservation of Sheep Grazing", by R F Hunter (Hill Farming Research Organization) The present article is based on these papers and on the discussions which followed them, and the views expressed are not necessarily those of the reviewer

The Scottish Highlands comprise, in a geological sense, that part of the country to the north and west of the Highland Boundary Fault This area, in addition to the traditional crofting counties, includes more prosperous farming counties such as Aberdeenshire, Moray, Nairnshire, Banffshire and parts of Perthshire It is in the crofting counties that the problems of depopulation, social decay and land degradation have reached serious proportions, and it is these that are causing concern

When considering the Highlands, and conservation there, it is important first to pose the question, what are we trying to conserve ? It must be realized that this is a devastated habitat if the human and domestic animal populations are considered, the ratio one to the other, and the density, in the poorest parts of the Highlands, are of the same order as in parts of Africa where the country is described as semi-desert

All the evidence shows that the Highlands were once much more fertile than they are to-day Remains of large trees are found in desolate peat bogs, hillsides now bare and scree-covered show a brown forest soil below the accumulated debris of erosion, remains of human habitations are found associated with the remains of very large red deer at elevations of more than 2,000 ft , where now there is only cotton grass, heather and *Nardus*

The blame for the present desolation that characterizes much of the Highlands has often been laid on a deteriorating climate, and while it seems fairly certain that the climate has got worse in the past 2,000 years—wetter and colder—this period coincides with man's first large-scale impact on Highland biological systems the two cannot therefore be separated, but wherever deterioration has occurred, man has been present It is therefore important to get an idea what the country was like before man interfered, if any conclusions about land-use reached are to be correct

The Highland vegetation about 2,500 years ago consisted mainly of forest, grading into shrubby heath at 2,000–3,000 ft , which merged into arctic alpine vegetation where the hills were high enough Tension zones would have existed between these vegetation types, and in the deteriorating climate both blanket and raised bog tended to form extensively, and these gradually killed out much forest on the higher slopes Felling and grazing would mean retreating forests on the lower slopes Work in another mountainous area, the English Lake District, has shown that if the nitrogen content of lake deposits is taken as a measure of soil fertility at the time of deposition, and the flora of that time assessed from pollen remains, then fertility fell at the same time as the forests were cleared.

Though the natural biological system has been evolved over millennia, and is best adapted to the environment, it is not practicable to re-afforest all the land that has been cleared in the past two thousand years, and a compromise must be reached.

The failure of the 1745 rising and the break up of the clan system, with the introduction of sheep to the Highlands on a large scale for the first time, resulted in rapid devastation of the forests, already depleted by earlier fellings, and the slow death of large forest areas due to the prevention of natural regeneration by grazing. Sheep have thus been abundant in the Highlands for only 200 years, and though compilation of an accurate record of sheep populations presents great difficulties, it does seem that while numbers in the Highlands have declined in the past ninety years, in the Southern Uplands they have remained steady. This decline is probably due in part to too great a drain being made on the meagre natural resources of the Highland areas: the rocks are in general metamorphic formations poor in nutrients, with more fertile sedimentary deposits only occurring in quantity in Orkney, Caithness and the Moray Firth area. Agriculture in these areas must therefore be at a lower level of productivity than in areas more favoured geologically and climatically. Recent work by the Hill Farming Research Organization has shown that one reason for the gradual decline in the fertility of sheep runs is the feeding and manuring pattern, which causes a redistribution of nutrients from one vegetation type to another; in addition there are the normal losses due to leaching and marketing sheep, which must be made good artificially. The high ratio of sheep to cattle has been cited as a cause of degradation, and as the presence of cattle helps to put right the damage due to differential manuring, the two animals are truly complementary; any relative increase in the numbers of cattle is therefore beneficial.

The problem of spread of bracken is important in the Highlands, and though clearance is expensive there appears to be little doubt that with modern methods much quite good land could be cleared economically.

A great increase in the land area under forest in the Highlands has already been achieved by private owners as well as by the Forestry Commission, and the Commission now has authority for 'social planting' in areas where it would normally be uneconomic. The soil types available for Highland afforestation are peaty podzols with iron pan, peaty gleys, iron podzols, brown forest soils and deep peat. Peaty podzols and deep peat are two difficult types available in large amounts, and on both these the problems of establishment have been solved, now that suitable ploughing equipment has been developed and the need for additional phosphate realized; additional potash will probably be required on many peat soils. Pole-stage crops at least can be raised on deep peat dominated by *Trichophorum*, and unless windthrow proves serious, plantations should be successful in many Highland areas hitherto considered unplantable. It must be remembered, however, that blanket bog is the climatic climax in many areas.

Erosion has often resulted from deforestation, long-term overgrazing and bad draining and ploughing practices; these causes of erosion can be eliminated, though much damage has already been done. If in the relatively equable climate of Scotland erosion never takes place on a tropical scale, sheet erosion still accounts for an enormous loss of top soil, though this is seldom admitted by farmers. The practice of repeated burning, especially on peaty soils, results in degradation of the flora and eventual erosion.

A number of interests and organizations are concerned with the Highlands—forestry, crofting, sheep and cattle farming, the Hydroelectric Board, fishing, shooting, and not least tourism. At present, these interests tend to go their own ways. Rural development surveys of a number of Highland areas covering more than 3,000,000 acres have recently been made by the Department of Agriculture, and in consultation with the Forestry Commission they are deciding the best division of land for each naturally demarcated area; however, there is no guarantee that owners and crofters will co-operate in these schemes.

The future of the Highlands is bound up with the future of crofting. Whether, in this age of mechanized agriculture, crofting as it is at present practised can survive is still doubtful. Unfortunately, such a haze of emotion overlies and obscures the whole subject that it is very difficult to obtain an objective view. Although where the Forestry Commission has been working on any scale the drift to the towns has been stopped, crofters are not always willing to work for the Commission, and labour may have to be brought into areas where unemployment relief was the original objective.

The integration of farming and forestry is a prerequisite of proper land use. There are, however, conflicting claims, for if lower and middle slopes of glens are planted with trees, the ratio of inbye to hill land —usually about 6.94 per cent, which is already too low—will be still further lowered. A possible solution is to use red deer as grazing animals for the high tops, treating them as a natural resource. The population of red deer is admitted to be higher than the land can reasonably carry, and as it is undesirable to re-introduce the carnivores which are the natural predators, man must control their numbers. For example, the Nature Conservancy has calculated that the herd of red deer on Rhum should be reduced by a half to two-thirds, and the same is probably true for most parts of the Highlands.

A comparison with other regions may show what is needed. In Sweden, agriculture is subsidized by forestry, and English and Lowland agriculture is effectively subsidized by industry, while in the Highlands, some of the natural resources, for example electric power and water, are exported with little or no return: the Hydroelectric Board benefits from afforestation by a reduction of the rate of silting in reservoirs, and water boards benefit from an evening-out of run-off.

Work by the Nature Conservancy, Forestry Commission Research Branch, and Hill Farming Research Organization, to mention only three bodies, is filling in many gaps in our knowledge of Highland biological systems, but the general impression the reviewer gained from this stimulating symposium was the need for more basic information, and for a more vigorous, integrated, approach to the Highland problem by all concerned.

W. O. BINNS

OBITUARY

Prof. G. O. Sherrard

With the death in September last of Prof. G. O. Sherrard, affectionately known to all as 'G. O.', horticulture in general and Irish horticulture in particular has lost a most distinguished devoted scholar. He was born seventy-six years ago on the family estate near Cork City. As a boy, he had two great ambitions, to become a gardener and to teach. His father appeared to have different ideas and sent him to Westward Ho, Old United Services College and later to Woolwich Military Academy, where he received his commission.

A wish to travel prompted Sherrard to volunteer for foreign service. He was sent to Gibraltar, where he contracted Malta fever. Home on sick leave and advised to adopt an outdoor life, he naturally and fortunately chose horticulture. The soldier turned gardener now trained at Albert College, and afterwards entered the Royal College of Science, Dublin, on a scholarship, where in 1910 he obtained the A.R.C.Sc.I.

After a short period as a teacher of rural science in Co. Kildare, he was awarded a scholarship by the Development Commissioners and went to the John Innes Horticultural Institution to study genetics and plant breeding under Prof. W. Bateson. He interrupted study for active service in the First World War, reached captain's rank and was awarded the Military Cross.

From war to study again, and then back to Ireland as lecturer in horticulture in the Royal College of Science. At the foundation of the Faculty of Agriculture in 1926 he transferred to University College, Dublin, where in 1940 he became professor of horticulture—Ireland's first horticultural professor.

The Royal Horticultural Society of Ireland awarded him its Gold Medal for conspicuous service to Irish horticulture in 1941, and in 1953 the Horticultural Education Association elected him as president, the first and only Irishman to be so honoured. He was an active member of the council of the Royal Horticultural Society of Ireland and was president of that Society during 1955–58.

Prof. Sherrard was a wonderful teacher and a fine research worker, who contributed nobly to Irish prosperity. In his life-time, he witnessed a complete change in the horticultural pattern—a transition from the big estate garden to that of the suburban villa, and the remarkable development of commercial horticulture within the past quarter of a century. Quick to perceive the change, and adequate to cope with the changing requirements, he provided trained personnel for advisory, research and administrative posts. He was an inspiration and guide at a very critical period.

Although Sherrard's name as a research worker tends to be linked almost exclusively with his wonderful pioneering work on Brussels sprouts, he found time during a very busy life to publish papers dealing with the nutritional, breeding and cropping aspects of vegetables, fruits and glasshouse crops. He gave many public lectures, wrote a book on fruit and vegetable growing, contributed weekly press articles on popular gardening, and through friendly informative weekly gardening talks from Radio Eireann became the doyen of Irish broadcasting.

His outstanding work has been concerned with the breeding and improvement of commercial strains of Brussels sprouts, on which he embarked in 1924. Out of the chaos of that time he created a high order, and as monuments to his skill, patience and abiding interest he has left behind such wonderful varieties as Glasnevin Supreme, Irish Elegance and the freezer Irish Glacier. In whatever clime this crop is grown, Sherrard's name will be remembered and honoured.

Modesty and simplicity were innate characteristics of the man who put Glasnevin and Ireland before self-exaltation. An octogenarian, thinking aloud at his graveside, summed up what all of us who knew him felt in our hearts—"he was a great man and a thorough gentleman". We are the poorer for his passing, but take heart from his fine example.

E. Clarke
A. Turner

NEWS and VIEWS

General Post Office: Engineering Appointments

The Postmaster General has approved the appointment of Mr. A. H. Mumford, deputy engineer-in-chief, to be engineer-in-chief in succession to Sir Lionel H. Harris, who is retiring on January 31. Capt. C. F. Booth and Mr. D. A. Barron, both of whom are assistant engineers-in-chief, have been appointed deputy engineers-in-chief.

Sir Lionel Harris, K.B.E.

Sir Lionel Harris joined the Post Office Research Branch at Dollis Hill in 1922, having spent four years with Signals in the Australian Imperial Forces and graduated in the University of London from the City and Guilds Engineering College. He was superintending engineer of the North Midland District of the Post Office on the outbreak of war in 1939, when he left to join his Territorial Army unit. After Dunkirk he successively commanded G.H.Q. Signals, was chief signal officer, Lines of Communication, and finally for two years chief of General Eisenhower's Telecommunications Section. After the War he became for four years director of the Post Office in Scotland, then controller of research and finally (in October 1954) engineer-in-chief.

Mr. A. H. Mumford, O.B.E.

Mr. A. H. Mumford was born in London in 1903 and was educated at Bancroft's School and the University of London. He entered the Post Office in 1924 as an assistant engineer; before very long he joined the Dollis Hill Research Laboratory, where he was particularly concerned with short- and ultra-short-wave radio systems and with multi-channel telephony and television transmission over coaxial cables He was involved in the development of the first trans-Atlantic radio-telephone service, visiting the United States in connexion with this in 1927 He was also closely connected with work on the remote-controlled short-wave radio transmitters when the Post Office Rugby Radio Station extension was being designed He was in charge of the Post Office Radio Branch during much of the war period He became deputy engineer-in-chief of the Post Office in 1954 Mr Mumford has been a vice-president of the Institution of Electrical Engineers since 1958

Capt C. F Booth, O B.E.

CAPT C F BOOTH started in the Post Office in 1923 and was for twenty-five years in the Radio Branch Laboratories of the Post Office Research Station at Dollis Hill He is an international expert on quartz-crystal and primary-frequency standards and is part author of a comprehensive text-book on the subject "Quartz Vibrators and their Applications" He is at present leading the United Kingdom delegation to the International Telecommunications Union Radio Conference in Geneva In 1952, Capt Booth was appointed deputy director of the newly established External Telecommunications Union He returned to the Engineering Department as assistant engineer-in-chief of the Post Office in 1954

Mr. D A Barron

MR D A BARRON was born in Bristol in 1907 and was educated at Bristol Grammar School and the University of Bristol He entered the Post Office Engineering Department as a probationary assistant engineer in 1927 and gained his early experience in the Technical Section of the former South Western Engineering District at Bristol and in Plymouth He was transferred to the Telephone Branch of the Engineer-in-Chief's Office in 1940 as assistant staff engineer In 1945, he led a team which went to India to prepare plans for the transfer of the Calcutta telephone service to automatic working On his return to Britain in 1947 he was placed in charge of a working party which examined the problems of subscriber trunk dialling which was introduced in Bristol a year ago He was appointed assistant engineer-in-chief in 1954

Animal Research at the Commonwealth Scientific and Industrial Research Organization

Mr D A Gill

MR D A GILL, chief of the Commonwealth Scientific and Industrial Research Organization Division of Animal Health and Production, has retired after a lifetime of service to the animal industry A graduate of the Royal College of Veterinary Surgeons, London, he joined the Organization in 1934, succeeding the late Sir Ian Clunies Ross as officer-in-charge of the McMaster Animal Health Laboratory in the grounds of the University of Sydney He took a leading part in the practical development of methods for the control of blow-fly strike in sheep He has been influential in improving facilities for research for the sheep industry and was closely associated with the establishment of the Organization's laboratories at Prospect and Armidale, New South Wales, and Yeerongpilly, Queensland For some years Mr Gill lectured on veterinary bacteriology at the University of Sydney During the Second World War he was seconded for a time as pastoral adviser to the Department of War Organization of Industry Instead of appointing a successor to Mr Gill the executive of the Commonwealth Scientific and Industrial Research Organization has decided to split the large division (which has an annual budget of £850,000) into three divisions, namely, the Division of Animal Genetics, the Division of Animal Health and the Division of Animal Physiology

Dr J M Rendel

THE new chief of the Division of Animal Genetics will be Dr J M Rendel, of Sydney Dr Rendel went to Australia in 1951 from the Institute of Animal Genetics in Edinburgh As assistant chief of the Division of Animal Health and Production he has taken part in much of the Organization's animal breeding work, and has been particularly interested in cattle In 1958 he made a report on the cattle industry in Papua and New Guinea for the Department of Territories

Dr T S. Gregory

DR T S GREGORY, of Melbourne, has been appointed chief of the Division of Animal Health, with Dr D F Stewart, of Sydney, as associate chief Dr Gregory has been on the Organization's staff since 1926, except for a period of eight years as lecturer in bacteriology at the University of Melbourne, and during the Second World War

Dr. I. W McDonald

THE Division of Animal Physiology will be led by Dr I W McDonald of Sydney Dr McDonald gained a Hawkesbury diploma in agriculture before undertaking his course in veterinary science at the University of Sydney Before being appointed officer-in-charge of the Organization's Sheep Biology Laboratory at Prospect in 1955, he had spent several years at the Institute of Animal Physiology in Cambridge, England

Underground Test Explosions in Britain

THE Prime Minister said in the House of Commons on July 30 that H M Government has decided that tests involving small underground firings of conventional explosives should be carried out in the United Kingdom to obtain information on the detectability of small underground nuclear explosions He emphasized that no radioactive materials would be used The United Kingdom Atomic Energy Authority more recently announced that preparations were in hand for the first series of tests to be carried out towards the end of this year in a disused mineshaft in the Kit Hill area, north of Callington, Cornwall The Atomic Energy Authority, in consultation with the Atomic Energy Division of the Geological Survey, has now located a suitable site for a further series of tests at the Greenside lead mine, Glenridding, Westmorland This mine was about to be closed The owners of the mine are co-operating in the arrangements and have agreed to carry out the civil engineering work involved in preparing the underground chambers in the mine for the tests Preparations at the mine will begin shortly, and it is planned to carry out the tests in a few weeks time The potential productive capacity of the mine will not be impaired by the tests. The proposed series of tests will investigate the effects of firing charges at greater depths, and of greater size than is possible in the Kit Hill mine. Precautions will be taken to ensure that there will be no surface disturbance or damage. It is planned to register the results on seismic instruments at various distances from the mine. Local authorities and other interests concerned are being consulted and planning permission is being sought.

British Neutron Source Thermal Reactor

THE United Kingdom Atomic Energy Authority has signed a contract with the Hawker Siddeley Nuclear Power Co. for the purchase of a reactor to be installed at the Atomic Energy Establishment, Winfrith, Dorset, to be in operation by December 1960. Contracts for shielding, and other equipment associated with the reactor, are being placed. The reactor, which will be known as *Nestor* (Neutron Source Thermal Reactor), is based upon the Company's *Jason* reactor. Its purpose will be to provide the neutrons required for the experimental assemblies of nuclear fuels and moderators which are used to obtain data for the design of future reactor systems. To meet the requirements of the Authority, the *Jason* reactor has been modified to be capable of continuous operation at a power of up to 10 kW. and its layout has been altered so that it can drive up to five experimental assemblies simultaneously. Details of the modifications have been worked out in collaboration between the Authority and the Company. The nuclear fuel in *Nestor* is an alloy of highly enriched uranium and aluminium arranged in an annulus. Natural water is used both as coolant and moderator. The reactor is capable of operation of 10 kW. giving a thermal neutron flux of 10^{11} neutrons per cm.^{2} per sec. in the centre of the core and of up to 10^8 neutrons per cm.^{2} per sec. in typical assemblies. The thermal neutron flux can be varied by altering the reactor power-level, by using neutron shutters or by arranging the fuel loading in the annular core.

Dungeness and the Nature Conservancy

IN the light of the Government's recent decision to consent to the construction of a large nuclear power station on Dungeness, the Nature Conservancy states that the direct and indirect repercussions of the power station on the remaining area show conclusively that the future scientific interest will be too much reduced to qualify it for the status of a national nature reserve. The proposed Dungeness National Nature Reserve is accordingly abandoned and the negotiations for it will not be pursued. The Conservancy will not, however, cease to concern itself with the preservation of such assets as can still be saved. For this purpose the undeveloped area (apart from that section now compulsorily purchased by the Central Electricity Generating Board) will remain designated by the Nature Conservancy under Section 23 of the National Parks and Access to the Countryside Act, 1949, as a 'site of special scientific interest', and the Conservancy will accordingly continue to be consulted about any further development which may be proposed for any other parts of the area. The Conservancy will in particular welcome and encourage any measures which the Royal Society for the Protection of Birds may be able to take for maintaining and defending the fauna and flora and, in particular, the bird-life of the 1,234 acres of shingle which it owns between the power station site, the Lydd Army Ranges and the bungalow settlement. If Kent naturalists wish to attempt further salvage work in the remaining area of the 'site of special scientific interest' they will have the Conservancy's support. The Conservancy will continue to keep in touch with the Central Electricity Generating Board and its contractors with the view of minimizing destruction of scientific interest over the area surrounding the power station site.

Field Studies

ANNUAL reports of the Field Studies Council have recorded accounts of scientific investigations which have been made in areas surrounding the Council's field centres in Pembrokeshire, Suffolk, Surrey, Yorkshire, Salop and Devon. The growth of these centres and the increasing amount of original work which is being carried out at them have made it impossible to publish anything but a small part of the material available. The Council has now decided to issue an additional publication about new knowledge being gained in field-studies connected with archæology, botany, geography, geology and zoology. "Field Studies" will appear once yearly and, in time, it is hoped that the series of papers published for each centre will have grown into a thorough local survey. The first issue ("Field Studies", Vol. 1, No. 1 (May 1959). Copies obtainable from the Publicity Secretary, Field Studies Council, Ravensmead, Keston, Kent. 5*s*.) describes the birds, land-use, farm practice, and climate of parts of the Dale peninsula, the land snails of Flatford, the geomorphology of the Tillingbourne, stratigraphy and pollen analysis of Malham Tarn and Tarn Moss, the geography of the Alberbury Breccia, and freshwater studies in the Shropshire Union Canal.

The Young Darwin

To mark the hundredth anniversary of the publication of Darwin's "Origin of Species", a commemorative oration was delivered by Prof. C. F. A. Pantin at Christ's College, Cambridge, on September 29 ("Young Darwin and the 'Origin of Species'." By Dr. C. F. A. Pantin. Pp. 17. Cambridge: Christ's College, 1959). The address was noteworthy for a number of features. Attention was concentrated not on an old man suffering from ill health but on the pleasant, virile young man who went up to Christ's College in 1828 to prepare himself for the Church, the reasons for Darwin's subsequent ill health were also examined by Prof. Pantin, who suggested that this may have been due not to any suppressed psychological antagonisms towards his father, but to the hardships and rigours encountered during the five-year voyage on H.M.S. *Beagle*, a 10-gun brig of only 242 tons. Darwin's contributions to knowledge in many branches of natural history include references to the origins of coral seas. There are also some valuable gleanings of the way in which "The Origin of Species" emerged.

The London Mathematical Society

THE annual general meeting of the London Mathematical Society was held on November 19 at Burlington House. The De Morgan Medal was presented to Sir William Hodge, physical secretary of the Royal Society and Master of Pembroke College, Cambridge. In presenting the Medal, the president (Prof. H.

Davenport) paid tribute to Sir William's distinguished work in algebraic and differential geometry Prof Davenport briefly reviewed the Society's affairs, and announced that a loan granted by the Nuffield Foundation had enabled the Society to begin reprinting those of its publications which are out of print He also announced that the Oxford University Press had agreed to publish the Collected Papers of G H Hardy, with the assistance of an editorial board appointed by the Society Prof H Heilbronn (University of Bristol) was elected president for the ensuing session The retiring president delivered his presidential address on "Some Recent Progress in the Analytic Theory of Numbers"

Model Marine Engines

LIVERPOOL Public Museums have recently placed on exhibition a series of working models of steam reciprocating marine engines They cover the period 1837–1937 and start with the side-lever paddle engine of 1837 Then comes a set of oscillating cylinder paddle engines of the 1840's Also in the paddle engines section is a set of diagonal compound machinery of about 1890 Screw propulsion came into general use during the 1840's and '50's, and the earliest model is of the horizontal return connecting-rod type All the remaining screw engines are inverted direct-acting The models are displayed working, and the side-lever and oscillating cylinder engines run at ten and twelve revolutions a minute, which is their correct working speed The other models run at forty revolutions a minute, which is well below the average speed of their real prototypes Running at this low speed is necessary, however, to preserve the bearings of the models, for they have been acquired for posterity as well as the present generation The models are fully described in a paper by Mr E W Paget-Tomlinson in the October issue of the *Museums Journal*

Replicas of Workshops

THE *Museums Journal* of September includes an account by Mr Keith Dunham of the workshops which have been reconstructed in the Museum of Science and Industry at Birmingham The city has always had a reputation for a multiplicity of trades, all of which have grown from the skill in iron-working possessed by the inhabitants since early times The building erected in the mid-nineteenth century in which this Museum is now housed was formerly the premises of a firm of silversmiths and electroplaters, and thus gives an excellent background for reconstruction of early workshops The trades chosen were those of the brass-turner, the action filer (gunmaker), the nailer, the jeweller and the cooper The workshops of a silversmith and brass-founder were already in existence Details of the display are given in the paper quoted

Phycology in Britain

THE recent issue of the *British Phycological Bulletin* (No 7, July 1959) contains the presidential address, "Buoyancy in Relation to the Ecology of the Fresh-water Phytoplankton", presented to the Society by Dr J W G Lund, together with abstracts of the other papers read at the London meeting in January 1959 There are also the first part of a list of the chromosome numbers in the Chlorophyta, notes on the algal herbaria of Hudson and Lightfoot, a list of marine algae collected in the course of field excursions organized during the Third International Seaweed Symposium held in Galway in July 1958, reviews of recent phycological literature and a number of shorter articles

Prize for Man-powered Aircraft Flight

THE Royal Aeronautical Society announces that a prize of £5,000 has been offered by Mr Henry Kremer for the first successful flight of a man-powered aircraft, designed, built and flown within the British Commonwealth under conditions to be laid down by the Royal Aeronautical Society The Royal Aero Club is to be invited to act as official observers The prize is offered personally by Mr Kremer and not by any of the companies with which he is associated Mr Kremer has been on the production side of industry all his life, and before the War pioneered the resin-bonded composition board industry After the War he began to take an interest in plastics, and in 1950 he formed Microcell, Ltd , which has been extended to include an aircraft engineering division and an electronics division, as well as the plastics division Since 1950 two other companies have expanded under his chairmanship, namely, Glass Yarns and Deeside Fabrics, Ltd , producing glass fibre, and Artrite Resins, Ltd Microcell, Ltd , has since merged with BTR Industries

Postdoctoral Awards U S National Science Foundation

POSTDOCTORAL fellowships are offered by the U S National Science Foundation to citizens of the United States with special aptitude for advanced training and who hold the doctoral degree or have the equivalent in training or experience Fellowships will be awarded in the mathematical, physical, medical, biological, engineering and other science fields, including anthropology, psychology (other than clinical), geography, certain interdisciplinary fields and selected social science fields A grant of 4,500 dollars a year will be awarded to successful applicants under the postdoctoral fellowship programme Dependency allowances will be made to married Fellows Fellows may engage in study and/or research at appropriate non-profit American or non-profit foreign institutions A limited allowance to aid in defraying a Fellow's cost of travel will also be available Further information can be obtained from the Fellowship Office, National Academy of Sciences—National Research Council, 2101 Constitution Avenue, N W Washington 25, D C All applications must be made by December 22

"Animal Clocks"

REFERRING to the report of his paper at the York meeting of the British Association in the symposium on "Animal Clocks", published in *Nature* of September 12, p 763, Dr Malcolm B Wilkins states that the last two sentences should read as follows "The period of the rhythm is slightly sensitive to temperature Ball and Dyke have shown that the growth-rate rhythm in *Avena* coleoptiles is inhibited in nitrogen, and Bunning has shown that the period of the rhythm of leaf movement of *Phaseolus multiflorus* is increased by the mitotic poisons colchicine and phenylurethane "

University News · Leeds

THE following grants are announced £4,310 for the period of one year from the National Coal Board, Scientific Department, for six research projects in mining , £3,860 from the Central Electricity Generating Board for research on the utilization of pulverized fuel ash in the Department of Agriculture

Dr A F Thomas has been appointed lecturer in the Department of Organic Chemistry

London

The following appointments are announced Mr P R Bell, of University College, to the University readership in botany tenable at that College , Mr A V Bradshaw, of the Imperial College of Science and Technology, to the University readership in extraction metallurgy tenable at that College

The title of professor of electrical engineering in the University of London has been conferred on Dr A H M Arnold, in respect of his post at King's College

Oxford

Research grants are announced as follow from the Department of Scientific and Industrial Research a grant not exceeding £35,900 for the period July 1, 1959, to July 31, 1962, for research on high-energy phenomena using photographic plates, being carried out under the direction of D H Wilkinson, professor of experimental physics , from the United Kingdom Atomic Energy Authority a grant not exceeding £8,500 for the period October 1, 1959, to September 30, 1962, for a study of polarized nuclear systems using resonance techniques, to be carried out in the Clarendon Laboratory under the direction of Dr F N H Robinson , and from the Ministry of Aviation a grant not exceeding £1,395 for the year beginning October 1, 1959, for research on the mechanism of operation of the cryotron, being carried out in the Clarendon Laboratory under the direction of Dr K A G Mendelssohn, reader in physics

Sheffield

It is announced that the Strength of Materials Laboratory in the Department of Mechanical Engineering is to be named the F C Lea Laboratory, in honour of the late Prof F C Lea, who was professor of mechanical engineering during 1923–36 and whose researches carried out in Sheffield made important contributions to knowledge in this field

Announcements

Mr Bryan Harris, a graduate in metallurgy from the University of Birmingham, has been appointed to a Tube Investments Research Fellowship for work in the physics and chemistry of solids, at the Cavendish Laboratory, Cambridge

Mr G G Gouriet is to give the Christmas Holiday Lecture of the Institution of Electrical Engineers on December 30, at 3 p m , and repeat it at the same time on the following afternoon He will speak on "Colour Television" Tickets, which are free, must be obtained from the Secretary, Institution of Electrical Engineers, Savoy Place, London, W C 2

The Science Museum, South Kensington, London, S W 7, has arranged the following Christmas lectures for boys and girls December 22 and 23, "From Man Power to Atomic Power", by Mr Victor Wall , December 28 and 29, "From Tinfoil to Tape the History of the Gramophone", by Mr John Cain , December 30 and 31, "The Story of Flight", by Mr Victor Wall , January 1, "Science and Magic", by Mr John Cain

The Zoological Society of London has arranged the following Christmas Lectures for children December 29, "Looking for Animals in East Africa" by Mr E H Tong , December 31, "British Carnivores" by Mr R F S Creed , January 4, "Animals in Hiding" by Mr D G Lambert The lecture hour is 3 p m and admission is free by ticket obtainable on application to the Education Department, Zoological Society, Regent's Park, London, N W 1 , only three tickets can be supplied to a Fellow for each lecture

The seventh Sir Thomas Middleton Memorial Lecture will be given in the Auditorium, Wellcome Building, 183 Euston Road, London, N W 1, on December 8 by Dr E B Worthington (deputy director-general (scientific), Nature Conservancy), entitled "Nature and Agriculture" Further information can be obtained from Miss D F Bray, Sir Thomas Middleton Memorial Trust, 3 Dean's Yard, London, S W 1

A two-day symposium has been arranged by the Linnean Society during December 17–18, entitled "Quaternary Ecology" The meeting will be held at Burlington House, Piccadilly, W 1 Further information can be obtained from the General Secretary, Linnean Society of London, Burlington House, London, W 1

The British Society of Rheology will hold a meeting in Manchester during April 7–8, and will include sessions on lubrication, disperse systems, and the methods and concepts of rheology , and a choice of visits to British Rayon Research Association, the Shirley Institute, Jodrell Bank and the Fluid Motion Laboratory of the University of Manchester Full details can be obtained from the Hon Secretary of the Society, 8 The Broadway, Pontypool, Mon

The Electronics and Communications Section of the Institution of Electrical Engineers, in association with the International Federation for Medical Electronics, is organizing the third International Conference on Medical Electronics which will be held at Olympia, London, during July 21–27, 1960 Further information can be obtained from the Secretary, Institution of Electrical Engineers, Savoy Place, London, W C 2

Sunvic Controls, Ltd , is to combine with the Instrument and Meter, Scientific Apparatus and X-Ray Departments of Metropolitan-Vickers Electrical Co , Ltd , to form the Instrumentation Division of Associated Electrical Industries, Ltd

It is announced by Birlec, Ltd , that the name of the company is to be changed to A E I -Birlec, Ltd The change coincides with the final reorganization of the structure of the parent company, Associated Electrical Industries Ltd , into several product divisions The internal organization of Birlec, Ltd , will not be affected The company will continue to operate as in the past for the manufacture of heat-treatment furnaces, gas plants and adsorption dryers The name of its associate company, Birlec-Efco (Melting), Ltd , will not be changed

Errata In the communication entitled "Nature of the Olefines produced by Apples" in *Nature* of September 26, p 996 par 2, line 15, for "1-hexane" read "1-hexene" , par 3, line 4, for "necessary" read "unnecessary"

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

LONDON GROUP LABORATORIES OPEN DAYS

THE British Iron and Steel Research Association recently held open days at its Battersea premises to show its members something of the current and continuing work of the London Group laboratories. Of the five Divisions and three Departments of the Association, the London Group comprises the Plant Engineering and Energy Division, part of the Iron-making Division, and the Physics, Chemistry and Operational Research Departments.

Notwithstanding the wide spread of interests represented, the displays clearly reflected the interest of the steel industry in automation and allied subjects. Not only has the Physics Department recently formed a new Section to deal specifically with the subject of automation, but also the Electrical Engineering Section of the Plant Engineering Division has pioneered several developments which, in effect, apply 'automation' in the handling of information.

Some years ago this Section developed a 'performance recorder' which recorded and stored production data, and processed it so that periodical tabulated totals would be available in printed form for office use. Equipment of this kind has since been installed in several British steel-works and other factories, and a development of the basic idea was designed and supplied for a big Russian contract for the erection and equipment of a giant tyre factory in the Soviet Union by a British consortium.

The Electrical Section of the Association has now completed a further development—the 'Tallimarker' system for conveying essential information in a steel-works. Starting from the premise that efficient production depends on accurate, easily accessible information, this automatic system represents a great advance on the traditional pattern of circulating data by paper chits or word of mouth. It consists basically of three essential units: 'push-button' desks, and display screens at key points along the production line, and a central 'memory'. As applied in a steel-works rolling mill, for example, the operators at the soaking pit, primary mill, primary shears, section mill and saw-bench, would all have press-button stations into which information is fed, and all stations after the soaking pit would have a display screen showing the previous history of the product as it is progressively reduced from the original ingot. As the ingot or subsequent bloom passes down the line, the operator at each point reads off the facts on his display screen, and feeds in more information as he completes his operation, for the following stations. When a section is being cut at the final saw, the 'Tallimarker' store holds the complete history of the section. Details are relayed to the mill office and recorded in the most convenient form; for example, on a teleprinter record, punched card or magnetic tape. The basic system can, of course, be adapted for use in any production line; in construction it is reliable, robust and accurate, reduces clerical work, and saves time and money.

The new Automation Section of the Physics Department is studying several possible applications of automation to steel-works production methods. Among these is a scheme for the automatic inspection and treatment of rolled billets, which often have surface defects which must be made good. The new plan is to dip the billet in a fluid which fluoresces under ultra-violet light, and which penetrates the flaws. The billet will then be washed and passed to an inspection chamber, where the flaws show up under ultra-violet lamps and can be detected by photocells. The photocells can be linked electrically with finishing tools such as grinders or de-seaming torches for automatic treatment. Billets without flaws would be diverted and stored, later rejoining the line in their original order.

The increasing use by manufacturers of steel sheet and strip has led to a growing pre-occupation with methods of quality control. Automatic gauge control was developed by the Association some years ago, and has been widely adopted in industry. On show at Battersea was a proposed new method of measuring small reductions in strip thickness, which can be integrated with automatic correcting equipment. The system is based on the fact that the reduced strip leaves the rollers faster than it enters them—the greater the reduction, the greater the change in speed. Therefore, by measuring the change in speed, the reduction can be calculated. It is proposed to do this by comparing identical signals obtained by photo-electric measurement of reflectivity at two points 'down the line'. The time-lag between the signals gives the time the sheet or strip takes to travel the distance between the points of measurement. One of these instruments before and one after rolling will give the change in speed, and therefore the reduction in thickness. This 'non-contact' method avoids any complications which would arise from the use of contact rollers or similar devices.

Because automatic control demands as an essential prerequisite exact information, instrumentation may be said to be the first step towards automation. An interesting new instrument is the 'bar section meter' displayed by the Physics Department. It has been designed to measure simultaneously four diameters of a hot solid bar at 45° intervals while it is moving at a high speed. This information is valuable not only for checking that the section is being rolled to the specified size, but also for early detection of such defects as finning.

The water-cooled viewing head forms images from the opposite edges of the bar across each diameter to be measured. These images are placed side by side in a single field of view, and are magnified and transposed so that the edges point towards each other. The instrument thus shows four parallel bands of light representing the four diameters measured. Each nominal diameter of the bar is set on the instrument by a micrometer adjustment; if this corresponds to the diameter being viewed, then the appropriate band is continuous across the field of view (that is, the fact that the edge images have been brought to coincidence in any band indicates that the diameter is as set) If there is a gap in the middle of the band, the diameter of the bar is less than the scale reading, while a bright central zone caused by the images overlapping indicates that the diameter is greater First experiments show that deviations in diameter of about 0 005 in can be detected

Leaving the theme of automation, an interesting sidelight on the technique of research was provided by the Ironmaking Division Although the blast furnace is a remarkably efficient vessel for the large-scale exercise in physical chemistry which iron-making represents, there is still much to be learned about the course of the reduction process There are severe limits on what can be deduced from experimental work on a blast furnace, and the Division therefore developed laboratory apparatus to simulate the reactions taking place in the blast furnace The *Scice* apparatus (stationary charge in controlled environment) metaphorically turns the blast furnace 'inside-out' In the blast furnace the charge moves down the stack, encountering changing conditions and undergoing various reactions, in *Scice* the charge is held stationary while gas of varying compositions and temperatures corresponding to these changing conditions is passed through it and reacts with it By controlling the conditions continuously, the ironmaking process can be reproduced and its reactions studied with relative ease

The practicability of this approach was originally proved in the laboratory by experiments using a charge container of three inches diameter A much larger and more elaborate version has now been installed at the Battersea Laboratories It incorporates a gas producer, gas absorbers, gas booster, electric heater for the gas, a reaction chamber 20 in in diameter by 24 in high, dust cyclone, and a gas cooler Instrumentation has been provided for flow-rates, temperatures, pressures and gas compositions, with provision for easy control of the variables This scaled-up version of the original bench conception provides a unique tool with which to solve some of the remaining unknowns about blast furnace operation

Also housed at Battersea is the Association's Operational Research Department, which now consists of three Sections Computer Applications, Operational Investigations and Human Factors

The first of these is primarily concerned with helping the steel industry to make use of the electronic computer This involves the use of the computer not only as a research tool but also as an administrative and/or production aid Using the Ferranti *Pegasus* computer installed at Battersea in 1958, the Section has carried out extensive studies of the feasibility and economics of using computers for such familiar problems as production scheduling, stock control, wage calculation, plant and process control, and allocation of materials, and already much valuable data have been collected

The Operational Investigations Section is operating a service—at present confined to the Association's member firms—whereby the Department's experience and facilities can be used to supplement managerial experience with forecasts of the effects of alternative policies A typical problem, involving a decision on stock control methods, was illustrated by displays The example taken was a company keeping large stocks of billets to ensure against production hold-ups This involved problems of locked-up capital and periodic rises in storage and transport costs

The first step was to analyse existing order and stock control methods From this, and from quantitative records, the main characteristics of production and raw material delivery over a long period were mapped out, and the effects of different control methods simulated on paper and carefully studied

Eventually, a set of 'ordering rules' was drawn up which in practice proved so successful as to release £100,000 of working capital by reducing the average stock-level, and a further saving of some £6,000 annually by reduced labour and transport costs

The Human Factors Section of the Department is concerned with such things as accident prevention, protection against heat and injury, and the broad subject of ergonomics, or 'fitting the machine to the man' In this latter field, displays showed many advances in control equipment design, aimed at reducing operator fatigue, eliminating strain and increasing efficiency An experimental control point was on display incorporating variable hand (and foot) controls, which has proved the genesis of a series of improvements already being adopted in production practice

It is, of course, impossible to give other than an arbitrary selection of the features of the display which, in any event, was representative of a part only (about one-third) of the whole programme of the British Iron and Steel Research Association This account, however, provides an indication of some types of problem being tackled and of the methods of approach

D U Hunt

COMPUTER LABORATORY AT THE UNIVERSITY OF LIVERPOOL

THE University of Liverpool has had a Mathematical Laboratory for more than twenty-five years—it was established by Prof L Rosenhead in 1934 shortly after he became head of the Department of Applied Mathematics The primary object of the Laboratory was always to train students in the honours school of mathematics and research students in other schools in the basic methods of numerical analysis applied to all branches of science

The Laboratory has always been well equipped with accounting machines as well as desk calculating machines An important feature of the teaching in the Laboratory has been the insistence on the fullest possible exploitation of all types of calculating aids, and much effort has been spent on not only investigating the possible uses of machines but also on developing methods suitable for them

The spectacular post-war growth in the demands for numerical analysis has led to very greatly increased demands being made on the Laboratory, the problems received for solution have been growing more numerous, more complex and greater in scope At first, the need was met in part by making use of punched card accounting machinery, and later by using the facilities of electronic computing establishments elsewhere—particularly at the University of Manchester, the generosity of which in this respect has been greatly appreciated by several other northern universities as well as Liverpool More than four years ago, however, it was already clear that the University of Liverpool should be equipped with its own computer, and detailed plans were made for the expansion of the Laboratory It was therefore with very keen disappointment that the University learned two years ago that money could not be provided at that time by the University Grants Committee for the provision of a computer

A survey made in the University had established the fact that the lack of an adequate computing service was causing research in some departments to be retarded seriously—particularly in the fields of nuclear physics and oceanography In view of this situation, the University Council decided that a computer must somehow be provided and an appeal was launched among local business concerns and friends of the University for donations towards the cost of purchasing a machine The response was generous—particularly as the appeal was made within a year of the major appeal to finance the general building development of the University—and as a result the University was able to place an order with the English Electric Co , Ltd , for a *Deuce*, the remaining balance of the cost being advanced by the University itself At the same time the staff of the Laboratory was increased and its name changed to the Computer Laboratory, Mr Andrew Young being appointed as its first director

The machine was installed and came into operation last July It is a 64-column *Deuce*, which is at present equipped with punched card input and output mechanisms A comprehensive range of punched card ancillary equipment—card punches, sorter, reproducer and tabulator—has also been installed, a card-operated typewriter is due for early delivery In addition, paper tape input and output devices and the necessary tape editing ancillary equipment have been ordered, but have not yet been delivered

The Computer Laboratory was officially inaugurated at an open day held on October 28, when the University entertained donors to the appeal fund and members of Council and Senate The guests were welcomed by the Vice-Chancellor, Sir James Mountford, and were shown over the Laboratory by the staff, the Director gave an account of the work being done in the Laboratory

It is already clear that the computer is meeting a very real need Extensive use of the machine is being made, as expected, by the Departments of Applied Mathematics, Physics—mainly analysing results of experiments made on the University's large synchrocyclotron—and Oceanography as well as several departments in the Faculty of Engineering, including the new Department of Building Science

What has surprised—and gratified—the University, however, is the unexpectedly large use of the machine by departments which had not hitherto been expected to use it extensively, if at all Some of the most frequent users are members of a group of physiologists working on a problem of liver function Members of the Department of Psychology and of the Medical Research Council are now analysing the results of gerontological studies with the computer, which, because of its ability to cope with the heavy arithmetic involved in factor analysis, has enabled them to extend their work In addition, educational, economic and social scientific surveys have been helped by the new computing facilities available

Training in programming and using the computer and its ancillary equipment is given regularly to members of the staff of the University, research students, and to outside users, a number of whom are making use of the machine on a basis of time-hire

It is now a commonplace occurrence that the installation of a computer leads to an expansion in the scope of the work undertaken in an institution, and it is already abundantly clear that in this respect the installation in Liverpool will prove to be no exception The University is proud of its new project, and is confident that the decision to embark on it will be fully justified

BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

A NEW format has been adopted for the 1958 annual report of the Electrical Research Association (Thirty-eighth Annual Report for the year ended 31st December 1958 Pp 103 Leatherhead Electrical Research Association, 1959) The report, which is attractively reproduced, departs from previous practice in having some fifteen illustrations, mostly photographs relating to research projects One diagrammatic illustration of special interest shows the proportions of the income of the Association coming from various sources and the distribution of expenditure among the main fields of research, in administration and in services to members

The total income of the Association for the year was just over £458,000, subscriptions from members totalling some £213,000, income from directly sponsored researches earning nearly £113,000, and the grant from the Department of Scientific and Industrial Research contributing £100,000 From the chart showing the distribution of expenditure it appears that some 9 per cent is used in administration A slightly greater amount represents services to members which, in addition to general technical liaison, cover the answering of requests for advice and information and the provision of abstracts Research expenditure appears under seven headings, divided as percentages of the total expenditure, roughly, as follows

Properties of materials	19	Applications of electricity	12
System problems	14	Transmission	6
Control and transformation	10	Specialized plant	10
		Miscellaneous researches	9

On the basis of expenditure, properties of materials thus represents, by a substantial margin, the biggest research effort of the Association, and it is evident from the report that this effort, which is devoted largely to insulation, has contributed both to fundamental knowledge and to technological progress. Much of the Association's technological work in this field has contributed to the drafting of British Standard specifications and similarly, at the international level, to the recommendations of such bodies as the International Electrotechnical Commission. During the past year the Electrical Research Association's recommendations relating to electrode systems for electric strength tests and for methods of measurement of permittivity and loss angle have been so adopted.

Work conducted at the National Physical Laboratory on the effects of electron and neutron irradiation of polythene is reported. It has been shown that the loss tangent of the material is little affected by irradiation dosages up to 10 Mrads, but thereafter increases due to oxidation.

Among the investigations of a fundamental character concerning the phenomena of instability in dielectrics, one may be mentioned dealing with the formation of gas in impregnated insulation. This has established the relation between moisture content and the stress required to initiate gas production. It has been possible to observe the slow growth of breakdown channels in a very viscous liquid and this forms the subject of one of the illustrations in the report.

A reliable technique has been developed for measuring the electric strength of liquefied gases, it having been established that the state of the electrode surfaces and particularly the degree of oxidation have a marked influence on the result. The parts played by anode and cathode have been separated by using electrodes in which the cathode and anode surface were different.

The influence of impurities on the magnetic properties of silicon–iron transformer sheet has been under investigation at the laboratories of the British Iron and Steel Research Association. It has been shown that, with respect to hysteresis loss, nitrogen is much more harmful than carbon, and two methods of minimizing the ill-effects of nitrogen are being examined. One method involves applying a thin coating of aluminium to laminations before annealing while the other utilizes a small admixture of titanium.

Theoretical work on deviations from Ohm's law in semiconductors has predicted that in sufficiently strong fields mobility should decrease with the 0·8th power of the field strength. This prediction has been confirmed by measurements made at Purdue University.

Circuit breaking and associated fundamental studies in arc physics continue to constitute an important part of the research programme. The temperature within the conducting core of the arc and, in particular, the formation of successive discrete cores as the current increases, have been studied in terms of dissociation and ionization, and it has been shown that the pinch pressures occurring at the electrodes outweigh the effects of natural convection and may provide an explanation of the phenomena of metal transfer in welding arcs.

Work on the creep properties of steel continues and is being extended. The first test-results have been obtained on the bursting of thick-walled pipes under creep conditions. A new laboratory to meet the needs of the augmented programme of work on creep testing is to be built at Leatherhead.

A result of considerable industrial significance has been obtained in the course of the programme of work on flame proofness and intrinsic safety. A re-evaluation of the maximum safe-gap for hydrogen made with improved research technique has shown the safe gap to be appreciably greater than was previously accepted. The value has been established as 11 mils. This opens up the possibility of designing flame-proof apparatus for use in hydrogen and some of the other most explosive gases.

The rural electrification work of the Association, which is concerned very largely with the application of electricity to agriculture and to horticulture, has, in the past, embodied a considerable programme of research on plant environment. This continues but it is now supplemented by a parallel programme on animal environment.

In a foreword to the report the president, Sir Josiah Eccles, points out that we are entering an era in which the scale and complexity of equipment and of automatic control systems will be such as to render capital charges a dominant factor in industrial costs. There will thus be an increasing premium on ingenuity and skill in producing more effective and cheaper equipment which, in effect, means an increasing emphasis on research. Bearing in mind that the vast majority of manufacturing firms in Great Britain employ less than 500 people and that many problems can be better tackled co-operatively than in specialized laboratories, it is evident that research associations have an important part to play in the effort to develop to the full the nation's scientific potential. In furthering this development the greatest responsibility falls, almost certainly, to the electrical industry. J. Greig

FLOW PROPERTIES OF BIOLOGICAL SYSTEMS

A MEETING, under the joint auspices of the Faraday Society (Colloid and Biophysics Committee) and the British Society of Rheology, was held during September 23 and 24 in the School of Physiology of the University of Oxford. On the first day, the flow properties of various biological systems were discussed, while the second day was devoted entirely to blood and blood vessels. The attendance of more than seventy included a number of overseas guests.

The Conference was opened by Prof. P. R. Allison, Nuffield professor of surgery, who welcomed the meeting to Oxford and spoke of the increasing importance of rheology in medicine and surgery. A general introductory lecture, under the chairmanship of Prof. M. Reiner (Haifa, Israel), was given by Dr. A. S. Lodge. Many of his audience were not rheologists and, for their benefit, Dr. Lodge outlined the scope and methodology of this branch of physics.

Several papers were read which concerned uterine cervical mucus and the connective tissue of the cervix. Dr. F. K. Beller (Tübingen, W. Germany) described the rheological changes which take place in human mucus during the menstrual cycle and following certain hormone treatments, and Dr R A Gibbons and Mr F A Glover (National Institute for Research in Dairying, Shinfield) discussed measurements of flow birefringence and the information which these might give concerning the size and shape of mucoid molecules Drs M L R and D R Harkness (University College, London) were concerned with the very marked changes which must take place in the lower end of the uterus and in the cervix to allow of the passage of the fœtus at parturition The concentration of collagen drops from 10 per cent (wet basis) in the non-pregnant animal to about a third of this amount during pregnancy

Drs J C White and P Elmes (London Postgraduate Medical School) described viscosity, intrinsic viscosity and thixotropy measurements on dilute bronchial mucoid sputum A special apparatus was designed to measure the yield-values of undiluted samples, which may be related to the force required to initiate movement of the mucus in the smaller respiratory passages Dr H J Rogers discussed hyaluronidase and hyaluronic acid

Living skeletal muscle has remarkable rheological properties, contracting rapidly and completely from extensions of up to 130 per cent, but this extreme elasticity is quickly lost *post mortem* J R Bendall (Low Temperature Research Station, Cambridge) spoke of the form of the deformation-time curves and the biochemical processes underlying the changes which take place in them Also concerned with muscle, Dr J J Connell (Torry Research Station, Aberdeen) described measurements of toughness and firmness of fish and of fish pastes and jellies as related to subjective assessments

Prof L V Heilbrunn (Philadelphia) discussed methods for measuring the rheological properties of protoplasm, and stressed the differences between these and the behaviour of purified proteins Prof J A V Butler and Dr A B Robins (Chester Beatty Research Institute, London) described simple viscometric measurements (using concentric cylinders) for the study of nucleic acid solutions , and the significance of intrinsic viscosities and of viscous anomalies such as dependence of viscosity on shear rate

Dr G W Scott Blair (National Institute for Research in Dairying, Shinfield) read two papers, the first of which dealt with the rather complex properties of milk coagulated by rennet which, at best, requires four parameters for its specification ('Burgers body') On the second day, he described similar experiments on coagulated blood, which, surprisingly enough, except in the earliest stages, requires only two parameters ('Maxwell body')

The symposium on blood was introduced by Dr L W Bayliss (University College, London) under the chairmanship of Prof I de Burgh Daly Dr Bayliss outlined studies which have been made on viscous anomalies in blood flowing through artificial capillaries, emphasizing the importance of the relatively easier flow which is found in the narrower tubes and which reflects axial movement of corpuscles Dr R L Whitmore (Nottingham) gave a theoretical treatment of these differential flow velocities of plasma and corpuscles in the living body By means of radioactive tracers, changes in concentration due to radial movements can be followed He discussed turbulent conditions, which also formed the theme of a paper by Dr W E Stehbens (Sydney, Australia and Oxford), who pointed out that, especially in the neighbourhood of bifurcations, turbulence takes place at quite low Reynolds' numbers Nor must the pulsatile nature of the flow be forgotten Streamline conditions are not as general in the body as used to be supposed Dr D A McDonald also discussed the hydrodynamics of pulsatile flow, basing his treatment on the theoretical work of the late Dr J R Womersley and of Dr M G Taylor

Prof A L Copley (New York and London) discussed the nature of the flow-curve of blood in glass capillaries which has recently been shown to follow Casson's equation (see G W Scott Blair, Nature, 183, 613 , 1959) When the surface of the capillary is coated with fibrin, the apparent viscosity falls and the differential flow velocities appear to be accentuated Moving 'indexes' of blood in sloping capillaries also adhere less to fibrin than to glass surfaces In the living blood vessel, an endo-endothelial fibrin film may constitute a major factor in helping circulation He also presented work on native blood and plasma and the effects of anticoagulants

Prof S Baez (New York) described pressure effects in living microscopic vessels and pointed out the important part which the tone of the vasculature plays, not only in hæmodynamics but also in those studies now often referred to as 'hæmorheology' Dr H Hartert (Heidelberg, Western Germany) discussed the rheology of his well-known technique for following the process of blood coagulation by measuring the progressive increase in shear modulus ('thrombo-elastography') and also described his more recent invention, the 'retractograph', which follows the process of retraction, claimed to start immediately at the clotting point and to increase in parallel with increase in the shear modulus Dr H H Pfeiffer (Bremen, Western Germany) described his measurements of rheodichroism, a phenomenon which throws much light on the molecular nature and characteristics of the so-called 'leptones' which are responsible for differential light absorption in flow Prof A Katchalsky (Rehovoth, Israel) and his colleagues discussed recent experiments on osmotic effects in individual erythrocytes These behave rather like football bladders, in that they are very readily deformed up to a certain degree of swelling, after which they offer enough resistance for the pressure quickly to exceed their apparent strength, a fact which may help to account for the comparative ease with which red cells appear to pass along very narrow vessels

In the afternoon of the second day of the meeting, there was an exhibition of apparatus Many of the instruments associated with the papers which had been read were on view The demonstrations were introduced by a lecture by Prof K Weissenberg in which he showed many strange rheological phenomena which, in less dramatic form, are likely to make their appearance in biological systems His own 'rheogoniometer' was among the exhibits

In the evening, films were shown which developed further the themes already described by Dr D L McDonald and his colleagues, by Prof S Baez and by Prof A L Copley, Dr G W Scott Blair and their colleagues Finally, Prof M H Knisely (Charleston) showed a film to illustrate his work on 'sludged blood'

Much of the success of the meeting was due to the excellent local organization, in the hands of Dr R G Macfarlane, who also acted as honorary treasurer The proceedings of the Conference will be published in book form early in the New Year under the joint editorship of Prof A L Copley and Dr G Stainsby

G W SCOTT BLAIR

BRITISH COLONIAL TERRITORIES

"THE Colonial Territories, 1958–59"* provides the usual convenient compendium of information to such further publications as "Colonial Research" dealing with the British Commonwealth and itself includes a 24-page chapter dealing with "Research and Surveys", to which grants totalling £800,824 were made from Colonial Development and Welfare Funds for a further 134 research schemes The recommendations of the meeting at Lagos in January 1958 for the future organization of research in West Africa have now been accepted by the Governments of Ghana, Gambia, Nigeria and Sierra Leone, and the West African Research Office came formally into being on April 1, 1959 The Government of Ghana has now abandoned its intention of taking over the West African Cocoa Research Institute, which will accordingly continue as a fully inter-territorial research body The Commission for Technical Co-operation in Africa South of the Sahara has decided to transfer the headquarters of the joint secretariat from London to Lagos

Approved technical assistance projects in the British-dependent territories in 1959 under the United Nations Expanded Programme of Technical Assistance (to which the United Kingdom Government at present contributes the sterling equivalent of 2,240,000 dollars a year) amounted to 1,062,750 dollars Expenditure from Colonial Development and Welfare Funds was £17 8 million and the Vote for Colonial Services included £24,223,000 as financial aid to Colonial Governments Exports (excluding Northern Rhodesia and Nyasaland) fell by £46 million and imports by nearly £80 million, including about £35 million in Hong Kong and Singapore and nearly £20 million in East Africa Capital formation in 1958 remained at about the same value as in 1957

Among some other points which may be mentioned are the rapid expansion of educational facilities, although the provision of new school places and additional teachers remains the over-riding problem in most territories In October 1958, the two universities and three university colleges in Central Africa had 3,783 students, compared with 3,400 the previous year, and there were 1,615 students at the University of Malaya, which serves Singapore as well as the independent Federation of Malaya Capital sums provided under the Colonial Development and Welfare Act for university institutions are now almost completely committed, and a main financial problem is now to provide the required increase in accommodation for residence and teaching The Singapore Polytechnic opened in November 1958 with 385 full-time, 506 day-release and 2,005 evening students, and a second new technical college in Jamaica opened in March 1958 with 60 students In Jamaica, 11,000 extra primary places were provided out of the 16,000 required, and in Uganda the number of African pupils in aided secondary schools has risen from 5,517 in 1951 to 17,306 in 1958

Attachments of American teachers to institutions in British Colonial territories continued under the Fulbright Agreement, and the Overseas Visual Aids Centre was officially opened in London in February Departments of health generally were able to meet increasing demands on all services while maintaining a fair balance between curative and preventive work Mass campaigns and surveys or pilot projects preceding them have been used extensively to combat endemic diseases, but although the incidence of malaria and yaws has been dramatically reduced in this way, tuberculosis remains a serious problem Progressive improvement in water supplies in rural and urban areas has considerably assisted the control of water-borne diseases The Institute of Health in Singapore was completed in 1958 with assistance of a grant of 1,500,000 dollars from Colonial Development and Welfare Funds, and during 1958, 144 medical students and 5 dental students from the Colonial territories were placed by the Colonial Office in teaching schools in the United Kingdom and the Irish Republic Several overseas governments are now contributing to the Applied Nutrition Unit at the London School of Hygiene and Tropical Medicine

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* Colonial Office The Colonial Territories, 1958–1959 Pp xxv+199 (Cmnd 780) (London H M Stationery Office, 1959) 10s 6d net

GERM-FREE VERTEBRATES: PRESENT STATUS

IN a recent publication by the New York Academy of Sciences résumés are given of a series of papers delivered at a conference held by the Academy during May 1958* It is divided into five parts the first and second are concerned with instrumentation and with rearing of germ-free vertebrates, the third is concerned with the biological characteristics of germ-free animals, the fourth and fifth describe ways in which germ-free animals have been successfully used as a tool to solve otherwise intractable problems and discusses future possibilities in this direction

It has taken thirty years of technical development to produce germ-free animals of most laboratory species and thereby refute the opinion of Pasteur that germ-free animals would not survive Although the methods adopted are subject to continuous improvement, simplification and standardization, they remain expensive and complex Nevertheless, the time has come when germ-free animals are produced on a limited scale for practical research projects and, since the maintenance of the germ-free state over a limited time is much simpler than the production of germ-free animals, a plea is made for wider support for centres to produce and distribute them Study of the physiology and nutritional requirements of germ-free animals is a necessary preliminary to their use in research In this connexion, it is noted that their lymphoid tissue is immature compared with that of conventional animals Plasma cells are present in small numbers and the amount of serum γ-globulin is much reduced.

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* Annals of the New York Academy of Sciences Vol 78, Article 1: Germfree Vertebrates Present Status By James A Reyniers and 30 other authors Pp 1–400 (New York: New York Academy of Sciences, 1959) 5 dollars

Germ-free animals are free from antibacterial agglutinins readily demonstrable in conventional animals, although in some instances antibodies are later developed due to antigen in the autoclaved diet. Undoubtedly germ-free animals will provide a useful tool for immunologists in such questions as the source of 'natural antibodies' or whether serum γ-globulin exists apart from that produced in response to an antigenic stimulus. Indeed, germ-free animals raised on diets free from antigenic materials would be a boon to immunologists. In one paper, germ-free animals were indispensable in experiments to refute the hypothesis that irreversible hæmorrhagic shock was due to absorption of bacterial endotoxins from the bowel.

Interesting experiments are described to show that the increased growth-rate of conventional chicks, reared on diets containing penicillin, did not occur in germ-free chicks, but did occur after particular bacterial species had been experimentally established in their intestines. Another paper gives an account of experiments which show that infection with *Entamoeba histolytica* produces no lesions in germ-free guinea pigs, whereas it produces extensive ulceration of the intestinal mucosa in conventional guinea pigs. The potential value of germ-free animals in investigation of dental caries is, of course, obvious. In addition, the process of ageing in germ-free animals offers possibilities, but very little has been achieved so far in this respect on account of competition for available germ-free animal accommodation. However, perhaps the most exciting possibilities of germ-free animals at present relate to investigation of latent viruses, cancer and the relationship between them. No work upon latent viruses with germ-free animals is reported but a beginning has been made with cancer.

Filtrates from methylcholanthracene-induced tumours in conventional chicks are not infective, but when such tumours are induced in germ-free chicks inoculation of cell-free suspensions, produced by filtration through coarse filters, produces tumours and inoculation of suspensions produced by filtration through fine filters produces a fatal wasting disease. Purification procedures and electron microscopy tend to associate the tumour-producing activity with microsomal or virus-like particles of 50–150 mμ diameter and the wasting disease with smaller particles (20 mμ). In uncompleted experiments with germ-free C_3H mice, no mammary tumours in the females or hepatomas in the males have appeared in 100 mice of which the oldest are more than 700 days, whereas in comparable conventional C_3H mice 90 per cent die of these tumours within about 300 days.

It seems that germ-free experimental animals are likely to prove indispensable tools to answer certain basic questions of capital importance in several fields of biological research; yet after these questions have been answered the value of germ-free animals may perhaps decline. This poses a difficult problem for those called upon to decide whether to support the production of germ-free animals, an expensive and long-term undertaking. A. W. GLEDHILL

WATER POLLUTION RESEARCH, 1958*

APPLIED scientific research must ensure that projects and results are directly relevant and immediately available, so it is satisfactory to see from the annual report of the work of the Water Pollution Research Laboratory that contacts with the industries and authorities concerned are increasing and producing useful conclusions. Apart from the report itself, information is exchanged through numerous publications in journals, the invaluable *Water Pollution Abstracts*, a new series entitled "Notes on Water Pollution", and several committees recently established where the Laboratory makes close contact with the River Boards, the Institute of Sewage Purification and the Federation of British Industries. Financial support by the latter body has enabled two new investigations of considerable importance to industry to be started, and there are many examples in the report of valuable short-term studies undertaken in collaboration with specific industries, often on a repayment basis. In particular, suggestions made by the Laboratory have enabled several firms to reduce the danger of pollution by simple changes in manufacturing processes instead of expensive purification plant, and anaerobic digestion has been shown to be suitable for the treatment of slaughterhouse wastes but not for whisky wastes.

In the field of automatic apparatus it is anticipated that the merits of the dissolved oxygen recorder developed and applied by the Laboratory will be recognized by commercial production. The use of continuous recorders for oxygen and temperature has made it clear that isolated samples often do not give sufficient information for the accurate assessment of the condition of a river.

The studies made in the Laboratory of the foaming of detergents, and their behaviour in sewage treatment plant, are of particular interest. As the detergents normally used are resistant to biological treatment in percolating filters or activated sludge plant, the effluents may cause objectionable frothing in rivers. Recently, a new active material has been developed by the industry and tests have shown that a much greater proportion is destroyed during sewage treatment. If this is confirmed in large-scale trials, and if it could then replace existing detergents, the state of many rivers and drinking-water supplies should be improved directly. There might also be a general improvement in the quality of many effluents, as the efficiency of treatment can be affected by the amount of detergent present.

It is to be hoped that successes in empirical investigations will not distract attention from more prolonged and fundamental studies which are likely to be more economical in the long run. For example, the detailed results of the analysis of domestic sewage are proving to be very interesting and it will be extremely useful to know exactly the nature of the substances which treatment must aim to destroy. Biologists will be encouraged to see the success of modern analytical methods for the detailed separation and identification of the components of such a complex material.

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* Department of Scientific and Industrial Research. Water Pollution Research 1958. The Report of the Water Pollution Research Board with the Report of the Director of the Water Pollution Research Laboratory. Pp. v+113+4 plates. (London: H.M. Stationery Office, 1959.) 7s. net.

Investigations of the toxicity of various substances and the effects of temperature on fish continue In these studies, and also in work on biological treatments of sewage, cyanides and phenols, it is interesting to see the growing significance of acclimatization of the organism or the community Most of the toxicity studies have been based on mortalities during relatively short periods of exposure, and it would now seem necessary to study the effects of much longer exposures on the growth, longevity and reproduction of fish

The survey of the Thames estuary, which has been an important part of earlier reports, is now nearing completion Some examples of the difficulties that arise in predicting the behaviour of this intricate system are to be found in this report Recent improvements in the treatment of some of the sewage discharged to the estuary have apparently not produced the expected improvement in estuarine conditions for much of the year It seems probable that dredging may have to be added to the numerous factors which must be considered, as it appears that a concurrent reduction in the removal of organic matter in this way could have masked the effects of the improvements

It may be helpful to direct attention to two errors which might lead the reader to erroneous conclusions In Fig 4, p 13, the continuous lines refer to a depth of 3 ft and the broken lines to 15 ft, not vice versa as in the key given In a section describing the work of the reviewer while at the Laboratory (p 85), the last paragraph should start, "The gross rates of oxygen production are nearly twice (not ten times) published values for various aquatic plants in optimum light but in stagnant vessels Static values for the plants used, obtained by extrapolating the flow curves, are much lower than the experimental stagnant results" D F Westlake

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UNIVERSITY OF OXFORD SECOND TANGANYIKA EXPEDITION

WITH the encouragement of the Government of Tanganyika, a second party from the University of Oxford visited the Mahali Mountains on the eastern shore of Lake Tanganyika during July to October to continue the work started by last year's expedition (see *Nature*, 183, 726, March 14, 1959)

The Mahalis form a small, well-defined, yet little known region, not typical of most of Tanganyika, where flora and fauna of East and West Africa meet Whereas last year's expedition concentrated on the southern half of the peninsula this year the base camp was farther north, at Kasoge, a short distance from Mount Kungwe (c 8,250 ft), the highest peak in the range

A collection of plants at all altitudes above lake-level was made by R M Harley and J G B Newbould, of the Botany School, Oxford The specimens have been sent to the Royal Botanic Gardens at Kew for identification and will be used in the preparation of the Flora of Tropical East Africa The collection includes a number of live orchids which are now in the orchid houses at Kew

The two zoologists made a general collection of birds, snakes and small mammals and also specialized in Arachnida and freshwater biology J A Cooke, of the Zoology Department, Oxford, made an exhaustive study of the spiders in the area and collected nearly 4,000 specimens D H Eccles, of the Bureau of Animal Population, Oxford, collected several hundred fish from the streams draining into Lake Tanganyika, using both poison and electric shock methods For two weeks the party was joined by G H Yeoman, of the Tanganyika Veterinary Department, who was investigating parasites on small mammals

W J Wadsworth and R C Herrera, of the Department of Geology, Oxford, made a geological investigation of the layered igneous intrusion at Kapalagulu, about 20 miles north-east of Mount Kungwe T E Stevens, of the same Department, completed a survey of the Mount Kungwe region itself Collections of rock specimens from these two areas will be examined in the Department of Geology, Oxford, and at the Geological Survey, Dodoma, Tanganyika

R Davis, of the Institute of Experimental Psychology, Oxford, conducted experiments on reaction times and visual perception among local inhabitants and tested 350 children in missions and native authority schools as part of a comparative study of African and European children A household survey of villages in the northern half of the peninsula was also undertaken

The members of the expedition participated in the social activities of the region and various features of local life were recorded, both photographically and on magnetic tape R Davis

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GEOMAGNETIC ACTIVITY AT HALLEY BAY ON DISTURBED DAYS

By J MacDOWALL

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THIS examination of the diurnal variation of geomagnetic activity at Halley Bay, lat 75° 31′ S, long 26° 37′ W, was based on *Q*-indices which occurred during the five most disturbed days in each month A year was formed from the twenty months observations and then divided into four seasons

Greatest activity occurred for the seven hours after local midnight in each season, but a significant seasonal change occurred in the form of the daily variation

Fig 1 shows that the mean activity of the year was of a similar form to the diurnal variation at the equinox However, Fig 2 illustrates the marked seasonal change in the form of the diurnal curve Near local midnight, activity started earliest in winter and latest in summer, but activity after mid-

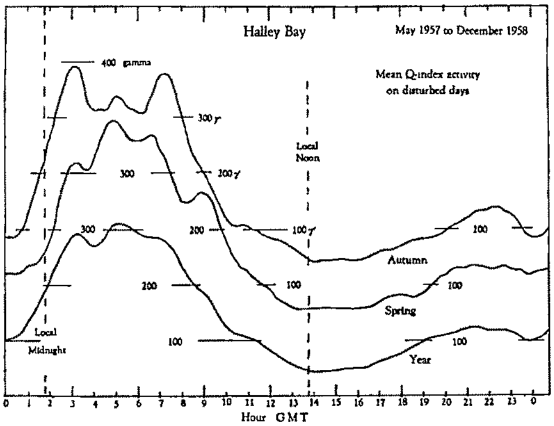

Fig 1 The general form of the variation was similar in these periods

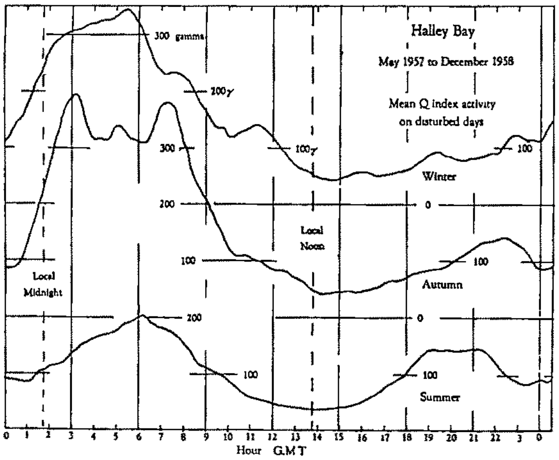

Fig 2 Seasonal changes to the daily variation of geomagnetic activity

night was greatest in autumn and least in summer. At 1115 G M T there was a subsidiary maximum of activity in the winter: this effect was just evident at 1015 G M T in autumn, but during summer there was no sign of this feature.

For most of the year the second most active period occurred in the evening and was separated from the main disturbance period by a brief minimum near 0000 G M T. Such evening activity was greatest and earliest in summer, and the equinox showed an intermediate type of variation. In the later aspect the seasonal change in the evening differs from the change in the early morning, where greatest activity occurred at the equinox. Further difference between the early morning and evening periods was revealed when the change with time in the sign of 'bay-like' disturbances (of types *b*, *bp*, *bps*, *bs*) was examined in Table 1.

Table 1 EFFECT OF TIME ON THE MAIN MOVEMENT OF THE HORIZONTAL AND VERTICAL COMPONENTS IN BAY DISTURBANCES, HALLEY BAY, JANUARY–JUNE 1958

Percentage of bay disturbances with certain signs

G M T period	H −ve Z +ve	H +ve Z −ve	Other signs	Total number all movements
15–18	0	100	0	5
18–21	3	82	15	31
21–24	43	24	33	51
0–3	93	1	6	78
3–6	93	0	7	56
6–9	93	0	7	14
9–12	100	0	0	5
Day	70	18	12	240

During the most active period from 0000 to 0600 G M T, field changes of such geomagnetic phenomena were almost entirely negative for the horizontal component and positive for the vertical component, but in the subsidiary active period before 0000 G M T. the reverse field movements were most frequent. The zone of maximum auroral frequency was situated just south of Halley Bay, so that the sense of the change of vertical force would indicate a weakening of the auroral zone electro-jet before 0000 G M T, which was followed by a recovery and an even greater strengthening in the early morning. The change of the horizontal component indicated a reversal in the direction of the overhead zonal disturbance current system at about 0000 G M T.

Other ionospheric effects were observed with a Union ionosonde, in particular, ionosonde blackout observations bore a different relation to Q-indices in the evening and early morning. In the winter of 1958, blackouts which occurred from 1900 to 2300 G M T were not associated with high Q-indices, whereas during blackouts from 0000 to 1500 G M T high Q-indices occurred. This relation is illustrated in Fig 3 with the aid of ionosonde blackout data kindly supplied by Mr W H Bellchambers. It is

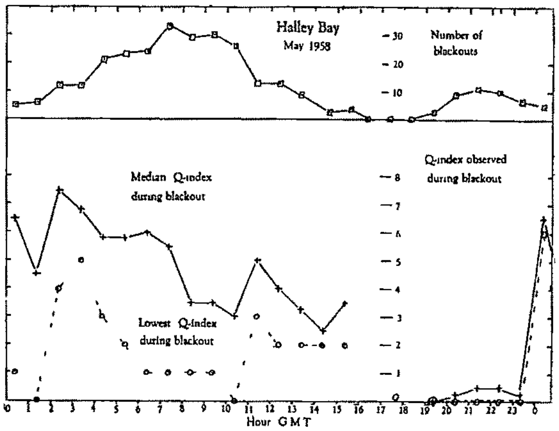

Fig 3 Geomagnetic activity which occurred during Union ionosonde blackout conditions

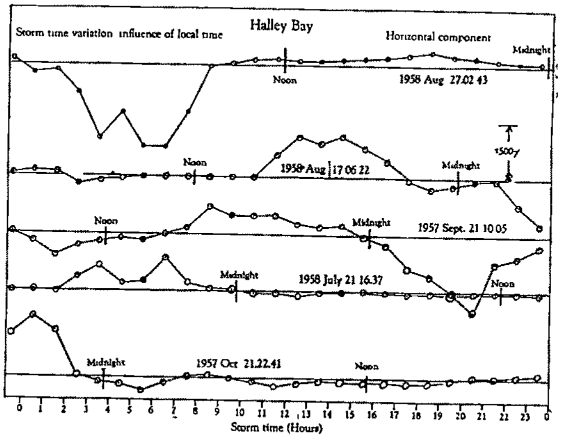

Fig 4 Influence of local time on the course of world-wide geomagnetic storms

also of interest to note in Fig. 3 the special nature of this relation near 1100 G.M.T., which may be compared with the peak in Q activity at 1115 G.M.T. in winter and shown in Fig. 2.

Nine occasions of confirmed world-wide sudden storm commencements (SSC) with commencements at different local times were examined. In Fig. 4 five of these storms are presented and show that the local time variations dominate the course of the storm. As in the case of bay disturbances, positive departures of the horizontal field occur before midnight and negative departures after midnight.

This work formed a part of the programme of the British National Committee for the International Geophysical Year; it was started at the Royal Society Base while I was seconded from the Meteorological Office. A full discussion of the results will be published as soon as possible. I gratefully acknowledge Mr. A. Blackie's assistance with the geomagnetic observations.

AN X-RAY STUDY OF RIGID-BODY AND INTERNAL VIBRATIONS OF ORGANIC MOLECULES

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THE intensity of diffraction of X-rays by a set of parallel crystal planes depends upon the arrangement of the atoms, their electron-density distribution and their state of motion. Hitherto, most crystal-structure analyses have concentrated on the obtaining of accurate atomic positions and thence the spatial configuration of the molecules. It is almost always assumed that the atomic scattering factor f is a spherical function and that the atomic vibrations are at least approximately isotropic. In 1941 E. W. Hughes showed that it was impossible to obtain good agreement between observed and calculated scattering amplitudes for the various diffracted beams from crystals of melamine unless it was postulated that the vibration normal to the molecular plane was larger in amplitude than that parallel to the molecular plane. Moreover, electron-density Fourier diagrams often show elliptical atomic contours, which may indicate a static non-spherical distribution but are much more likely to indicate non-spherical motion. Fourier diagrams obtained from neutron-diffraction observations likewise show elliptical contours, and these must certainly indicate non-spherical movements (or at least displacements) of the nuclei. If the ellipticity persists at low temperatures then there is the possibility, of course, that it may indicate some kind of disorder or uncertainty in the atomic positions. The diffuse spots and streaks which form the elaborate patterns found on well-exposed X-ray photographs taken of stationary crystals using characteristic radiation are also due either to atomic or molecular thermal vibrations, or (if they are not variable with temperature) to zero-point energy or disorder. Finally, the large degree of anisotropy of thermal expansion usually found in organic crystals and easily measured accurately by X-ray diffraction methods proves that the lattice or molecular vibrations must also be anisotropic.

With the advent of high-speed computers, it is now possible to obtain for each atom, at least in the case of relatively simple molecules, not only the atomic co-ordinates but also sufficient constants to indicate the directions and magnitudes of the principal atomic thermal vibrations. (The details of the *Pegasus* computer programmes used in this work will be published elsewhere.) Making the simplifying assumption that the atomic vibration figure is an ellipsoid, this involves $(9n + 1)$ unknowns for a molecule containing n independent atoms: that is, we require for each atom three co-ordinates x, y, z; three principal atomic Debye factors B_X, B_Y, B_Z; three orthogonal directions to give the orientation of the atomic vibration ellipsoid, $\vec{X}$, $\vec{Y}$, $\vec{Z}$; and a scaling factor to put all diffraction amplitudes on an absolute scale. The accuracy with which these unknowns may be experimentally determined depends upon the number of available *hkl* diffraction intensities (these usually amount to several hundred, depending upon the size of the unit cell) and upon the precision achieved in making the intensity measurements. This can be tested by repetition, especially using more than one crystal, but is also dependent upon the success with which data can be scaled together when recorded on more than one film or under different conditions in respect of the geometry of the diffracted beams and the recording device. It is, in short, essential that systematic errors be avoided if an accurate determination of molecular and atomic vibrations is required.

Cruickshank[1] has pioneered in showing how to extract information about the translational and librational amplitudes of the molecule, treated as a rigid body, from the atomic thermal-vibration ellipsoids. He has, however, accepted Higgs's suggestion[2] that, compared with these rigid-body movements, the intramolecular vibrations, which distort the molecule, will be small.

We are able to prove that this is not always the case, and that if and when the internal vibrations are comparatively small, it may still be possible to deduce them from the experimental observations. Perhaps the most obvious proof is that even diamond, which is an infinite three-dimensional molecule, does show temperature-dependent diffuse spots (Lonsdale[3]), that it does expand (Thewlis and Davey[4]) and eventually becomes transformed into graphite. The root-mean-square $(\overline{u_X^2})^{1/2}$ amplitude of atomic vibration in diamond is about 0·04 A. (as deduced from the Debye temperature. Lonsdale[5] gives a value of $\overline{u^2} = 3\overline{u_X^2}$ which is too low) even though each atom is bonded to four others. Since $B_x = 8\pi^2\overline{u_X^2}$, the value $(\overline{u_X^2})^{1/2} = 0·04$ A. will correspond to a Debye factor of 0·13 (A.²) and this, although small, is not negligible.

One of us (H. J. M.) has calculated, from 3-dimensional powder data kindly supplied by Dr. G. E. Bacon, the Debye factor for graphite [0001] and has found the value 0.63, which corresponds to a root-mean-square vibration amplitude of about 0.09 A. Graphite has 'infinite' two-dimensional molecules which cannot undergo 'rigid-body' translations or librations. All vibrations must be intramolecular or distorting vibrations, and hence 0.09 A gives some measure of the internal vibration amplitude that is possible for an atom tightly bonded to two others, the vibration being normal to the plane of the bonds. In this case, however, the anisotropy of the electron-density distribution and hence of the atomic scattering factor must certainly be taken into account, and this will be considered elsewhere. What is relevant here is that intramolecular thermal vibrations alone, without translations or librations, are responsible for the thermal-expansion coefficient of graphite, which between 0° and 800° C is 28.2×10^{-6} (°C.)$^{-1}$ along [0001] (Nelson and Riley[6]).

A refinement of the hexagonal boron nitride (BN) structure, for which even with very careful intensity measurements Pease[7] only attained an R-factor of about 17 per cent, shows that by re-scaling and imposing anisotropic B-values of 0.7 in the molecular planes and 1.4 along the van der Waals [0001] bonds, R is reduced to 4.7 per cent. Certainly there is here also some bond anisotropy to be taken into account, but part, at least, of B [0001] must be due to thermal vibration and this value corresponds to a root-mean-square amplitude of intramolecular out-of-plane vibrations of 0.13 A. This larger magnitude as compared with the graphite out-of-plane vibrations fits well with the larger boron nitride thermal-expansion coefficient α $[0001] = 40.5 \times 10^{-6}$ (0–800° C.).

These coefficients of expansion, however, are small compared with those of most aromatic compounds (Lonsdale[8]), and we may undoubtedly expect that in the case of plane finite molecules separated from their neighbours by van der Waals distances, the principal cause of expansion will be the librations involving out-of-plane movements.

Our studies of a number of simple organic molecules have shown that, given a structure for which the residual-error factor R is small (preferably well below 10 per cent), it is possible to deduce, within limits, numerical values not only of the translational and librational vibration amplitudes but also of intramolecular amplitudes; and that the internal molecular vibrations that emerge from these analyses are reasonable ones. A similar analysis carried out on earlier Debye factors corresponding to higher R values (say of upwards of 12 per cent) simply produces nonsense. A useful check on the vibration pattern may be obtained by carrying out an independent structure and vibration analysis on the same compound at another temperature, or on an isomorphous or isostructural compound.

Following Higgs[2], we assume that the various molecular vibrations are independent of phase and that the resultant mean-square amplitude in any given direction is the sum of the mean-square amplitudes of atomic vibrations of all kinds, rigid-body or distortional, in that direction. For each molecule we may specify three principal directions of vibration, say $\vec{L}$, $\vec{M}$, $\vec{N}$ (Fig. 1), and for each atom in the molecule we have three principal directions $\vec{X}$, $\vec{Y}$, $\vec{Z}$ given by our X-ray analysis. These may be deduced from Fourier analysis (for example, $\vec{R}$, $\vec{T}$, $\vec{N}$ in 1.3.5-$C_6H_3Cl_3$) or postulated on grounds of symmetry and probability; thus, in di-*para*-xylylene, $C_{16}H_{16}$ (Brown[9]), the most likely $\vec{X}$, $\vec{Y}$, $\vec{Z}$ directions coincide at least approximately with the molecular $\vec{L}$, $\vec{M}$, $\vec{N}$. The actual determinations of $\vec{X}$, $\vec{Y}$, $\vec{Z}$ purely by computer refinement is the weakest link in the whole chain, being subject to very large standard deviations indeed. In fact, if one refines a molecule known to be *symmetrical* as if it were not (that is, using the computer programme for a less symmetrical space group) then the values produced for both B_X and $\vec{X}$ are found to be *asymmetrical*, especially in early stages of the refinement. But whereas the B_X values for atoms related by symmetry converge (if the data are good) to a point where they may justifiably be averaged, the $\vec{X}$ values do not necessarily do so. The machine, in fact, may attempt to improve the agreement between observed and calculated structure amplitudes by producing nonsense; and in the case of molecules having symmetrical formulæ an informed guess at the directions of $\vec{X}$, $\vec{Y}$, $\vec{Z}$ is probably better than an averaging of widely differing computer-produced values; although it may be advisable to try more than one such trial set of directions.

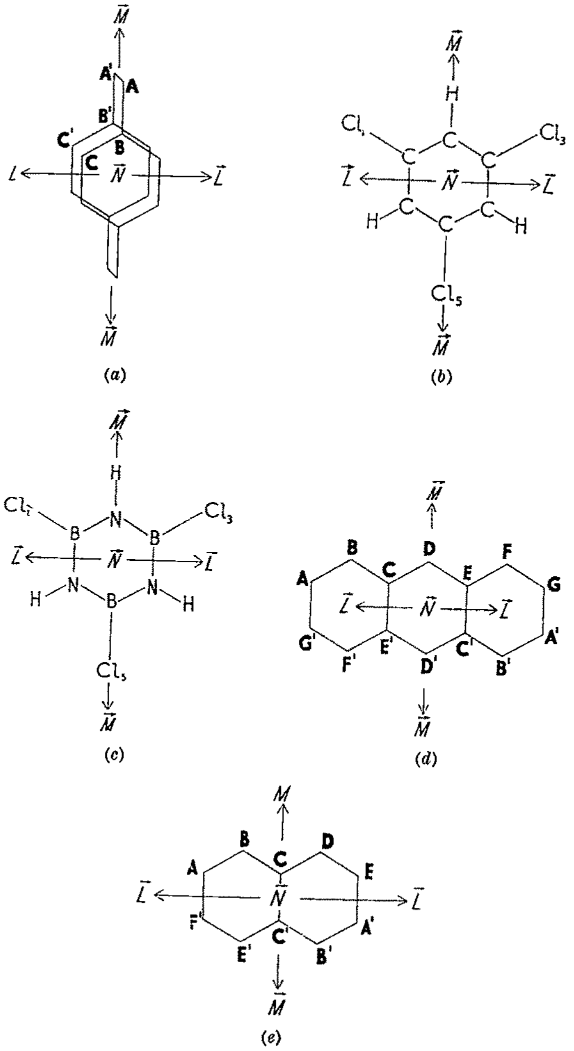


Fig. 1. Principal molecular directions assumed for $C_{16}H_{16}$, *symm.* $C_6H_3Cl_3$ ($C_6H_3Br_3$), $B_3N_3H_3Cl_3$, $C_{14}H_{10}$ and $C_{10}H_8$

We begin, therefore, with values of the molecular geometry and with three principal Debye factors B_X for each atom, derived from a large quantity of diffraction data. Let us call the mean-square rigid-body translation amplitudes t_L^2, t_M^2, t_N^2 (A.²) and the rigid-body libration amplitudes φ_L^2, φ_M^2, φ_N^2 (radians²) and let us then obtain a set of equations for $\overline{u_X^2}$ ($= B_X/8\pi^2$) for each atom **A**, **B**, **C** in the molecule. The movement due to libration, although along an arc, may be, for small displacements, taken as being along a tangent normal to the perpendicular (length R) from the atom to the axis of libration. Its mean-square amplitude will be $R_L^2\,\varphi_L^2$ (A.²). We wish to find t_L, t_M, t_N, φ_L, φ_M, φ_N, and also $\mathbf{A}_X$, $\mathbf{A}_Y$, $\mathbf{A}_Z$, $\mathbf{B}_X$ … $\mathbf{C}_Z$ which are the independent atomic vibration amplitudes along $\vec{X}$, $\vec{Y}$, $\vec{Z}$. The latter may be expected to combine into a few simple proper vibrations of the molecule. The whole system of vibration must explain the anisotropy of thermal expansion.

The details of the calculations will be published elsewhere, but it is possible to give here a selected example to illustrate the procedure. Consider $C_{16}H_{16}$, the molecule of which consists of two facing benzene rings linked by $(CH_2)_2$ bridges in *para*-positions[9]. The space group is $P4_2/mnm$ and the molecule (Fig. 1) has *mmm* symmetry. There are therefore only three independent atoms **A** (—CH₂—), **B** (—C$\langle$) and **C** (—CH=). The equations describing the $\vec{M}$ and $\vec{N}$ movements of these atoms are (at 291° K.):

$$\overline{u^2}\,(\mathbf{A},M) = t_M^2 + 0.66\,\varphi_L^2 + \mathbf{A}_M^2 = 0.0916 = 7.24/8\pi^2 \qquad (1)$$

$$\overline{u^2}\,(\mathbf{B},M) = t_M^2 + 1.89\,\varphi_L^2 + \mathbf{B}_M^2 = 0.0737 = 5.82/8\pi^2 \qquad (2)$$

$$\overline{u^2}\,(\mathbf{C},M) = t_M^2 + 2.38\,\varphi_L^2 + 1.42\,\varphi_N^2 + \mathbf{C}_M^2 = 0.0946 = 7.47/8\pi^2 \qquad (3)$$

$$\overline{u^2}\,(\mathbf{A},N) = t_N^2 + 7.98\,\varphi_L^2 + \mathbf{A}_N^2 = 0.0753 = 5.95/8\pi^2 \qquad (4)$$

$$\overline{u^2}\,(\mathbf{B},N) = t_N^2 + 1.91\,\varphi_L^2 + \mathbf{B}_N^2 = 0.0547 = 4.32/8\pi^2 \qquad (5)$$

$$\overline{u^2}\,(\mathbf{C},N) = t_N^2 + 0.51\,\varphi_L^2 + 1.42\,\varphi_M^2 + \mathbf{C}_N^2 = 0.0619 = 4.89/8\pi^2 \qquad (6)$$

From (1) and (2) we have

$$\mathbf{A}_M^2 = 0.0179 + \mathbf{B}_M^2 + 1.23\,\varphi_L^2$$

and therefore $\mathbf{A}_M^2 > 0.0179$ (A.²), $\mathbf{A}_M > 0.13$ A.

(The estimated standard deviation in $\overline{u_X^2}$ is about 0.006 A.², corresponding to 0.5 in $\mathbf{B}_X$.) From (4) we know that $7.98\,\varphi_L^2 \leqslant 0.0753$ (t_N^2, $\mathbf{A}_N^2$ are zero or positive) and from (5) $t_N^2 \leqslant 0.0547$ (φ_L^2, $\mathbf{B}_N^2$ zero or positive). Both these equalities could not, of course, be true simultaneously. From (4) and (5)

$$6.07\,\varphi_L^2 = 0{\cdot}0206 + (\mathbf{B}_N^2 - \mathbf{A}_N^2)$$

A large value of $\mathbf{A}_M$ would involve considerable stretching of bonds, unless $\mathbf{B}_N$ and $\mathbf{C}_N$ also have medium to large positive values, and therefore it is probable that $\mathbf{B}_N^2 > \mathbf{A}_N^2$, since $\mathbf{A}_N$ would not be large for any reasonable molecular vibration. If $\mathbf{B}_N^2 > \mathbf{A}_N^2$, then

$$0.0094 > \varphi_L^2 > 0.0034$$

which gives $\mathbf{A}_M^2 - \mathbf{B}_M^2 > 0.0221$, $\mathbf{A}_M > 0.15$ A. and

$$t_M^2 < 0.0673 \qquad t_M < 0.26 \text{ A.}$$
$$t_N^2 < 0.0482 \qquad t_N < 0.22 \text{ A.}$$

By a series of similar approximations we arrive at the values shown in Table 1, the limits of error being based on the indeterminacy inherent in the argument and not on possible experimental errors in the $\overline{u_X^2}$. This means that the actual numerical values may still need adjustment, although we believe the general pattern to be a correct one.

Table 1. PROBABLE RANGES OF VALUES OF INTERMOLECULAR AND INTRAMOLECULAR ROOT-MEAN-SQUARE VIBRATION AMPLITUDES FOR DI-*para*-XYLYLENE MOLECULES AT 291° K. AND 93° K., RESPECTIVELY

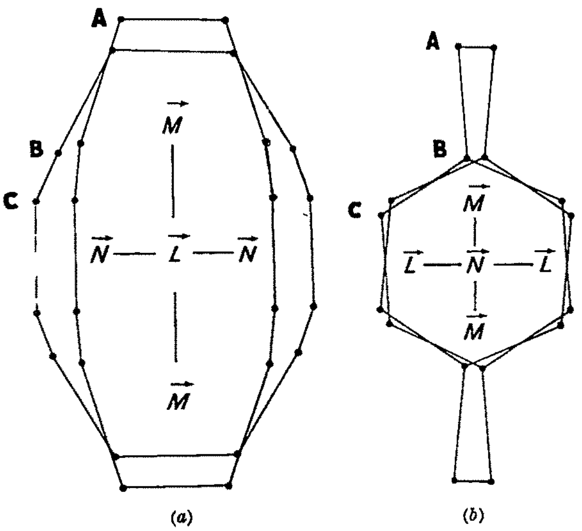
		t_L	t_M	t_N	φ_L	φ_M	φ_N	
291° K.	>	0.16	0.235	0.14 A.	0.065	0.045	0.065	radians
	<	0.21	0.255	0.21	0.085	0.08	0.085	
93° K.	>	0.14	0.15	0.09 A.	0.045	0.03	0.03	radians
	<	0.16	0.16	0.14	0.065	0.065	0.05	

		$\mathbf{A}_L$	$\mathbf{B}_L$	$\mathbf{C}_L$	$\mathbf{A}_M$	$\mathbf{B}_M$	$\mathbf{C}_M$	
291° K.	>	0.10	0.07	0	0.14	0	0.07	A.
	<	0.17	0.12	0.10	0.17	0.06	0.12	
93° K.	>	0.08	0.045	0	0.095	0	0.065	A.
	<	0.13	0.07	0.065	0.11	0.045	0.08	

		$\mathbf{A}_N$	$\mathbf{B}_N$	$\mathbf{C}_N$	
291° K.	>	0	0.07	0.10	A.
	<	0.06	0.14	0.20	
93° K.	>	0	0.045	0.045	A.
	<	0.045	0.10	0.125	

The rigid-body librations are such that the maximum values of $R_X\varphi_X$ are about equal in magnitude to the translational amplitudes. They are reduced by about one-third at 93° K. as compared with room temperatures, but the general pattern is the same although the complete structure analyses at the two temperatures are entirely independent (Lonsdale, Milledge and Rao, *Proc. Roy. Soc.*, in the press).

The internal movements are such as to imply two principal distorting vibrations of the molecule (Fig. 2). The first is a concertina movement involving $\mathbf{A}_M$ and $\mathbf{C}_N$, with smaller movements of $\mathbf{B}_M$, $\mathbf{B}_N$. The second is a twisting movement involving $\mathbf{A}_L$ and $\mathbf{B}_L$ with smaller $\mathbf{C}_L$ and $\mathbf{C}_M$ vibrations. There will be other movements superimposed on these, but only



(a) (b)

Fig. 2. Molecular vibrations found for di*para*xylylene, $C_{16}H_{16}$

Table 2

	$C_6H_3Cl_3$ (293° K)	$C_6H_3Cl_3$ (93° K)	$C_6H_3Br_3$ (room temp)	$B_3N_3H_3Cl_3$ (room temp)
t_L (A)	0 195	0 115	0 155	0 24
t_M (A)	0 16	0 07	0 13	0 20
φ_N (radians)	0 085	0 03	0 05	0 065

these are clear , and it will be seen that they involve amplitudes comparable with, though smaller than, the t and $R\varphi$ values We are investigating other compounds (*bis*-2 7-dimethylene naphthalene and di-*m*-xylylene) where a forced proximity and parallelism of aromatic rings may be expected to imply large internal vibrations of the molecule

We have also studied 1 3 5-$C_6H_3Cl_3$ (at 293° K and 93° K) and 1 3 5-$C_6H_3Br_3$ (Milledge and Pant[10] , Milledge and Lonsdale, in the press) and we have refined the structure of *BBB*-$B_3N_3H_3Cl_3$ originally analysed by Coursen and Hoard[11] The first two are isomorphous, the latter has a structure closely similar in orientation of the molecules, although not isomorphous (Lonsdale, in the press) The data for the benzene compounds are insufficient to give a complete vibration analysis, but they do give the approximate values of t_L, t_M and φ_N shown in Table 2

It will be seen that the magnitudes are comparable with those obtained for $C_{16}H_{16}$, but that the heavier isomorph has the smaller vibrations

The independent vibrations of the three chlorine atoms in $C_6H_3Cl_3$ are not equivalent In a direction tangential to the benzene ring the atoms Cl_1 Cl_3, Cl_5 (Fig 1) have mean-square amplitudes 0 0136 , 0 , 0 0324 A ^{2} respectively, at 293° K (or possibly 0 0136 $+ k$, k , 0 0324 $+ k$, with a corresponding reduction in $\varphi_N{}^2$ A weakness of our simple method is that it cannot distinguish these two possibilities) To eliminate these differences would involve errors of 1 0 and 2 5, respectively, in the measurement of the Debye factors, whereas the estimated standard deviation is only about 0 25 Nor is it unreasonable that they should differ, since the bonds linking them to neighbouring molecules are different for the three chlorine atoms

The molecule of $B_3N_3H_3Cl_3$ has a plane of symmetry parallel to $(0\overline{1}0)$ The chlorine atom on the mirror plane has $\overline{u_T{}^2}$ (tangential to the ring) greater than that of the asymmetric chlorine But there are also indications of a marked independent movement of the boron and nitrogen atoms normal to the molecular plane This is consistent with the [0001] movements in hexagonal boron nitride previously mentioned

Finally, we may consider anthracene and naphthalene Previous thermal analyses of anthracene have been based on experimental data which were only claimed to be accurate to about 10 per cent (Mathieson *et al* [12]) and which more accurate recent data have shown to be subject also to some systematic errors No complete set of accurate 3-dimensional $|F|$ values is yet available, but two partial sets, one 3- and one 2-dimensional, measured by Geiger-counter and photographic methods respectively, agree to 3 5 per cent and refine to 4 4 and 5 6 per cent, to give molecular geometries and B_X values which differ by far less than the estimated standard deviations calculated for either set separately Moreover, independent two-dimensional data at low temperatures refine to 6 6 per cent to give a similar, though reduced, thermal vibration pattern

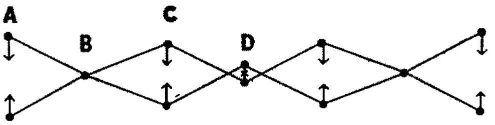


Fig 3 One possible vibration of anthracene, $C_{14}H_{10}$

Cruickshank[1] gave the thermal amplitudes for each atom A—G (Fig 1) in tangential, radial and normal directions with respect to the mass centre and plane of the molecule We believe that the experimental data indicate that $\overrightarrow{L}$, $\overrightarrow{M}$ and $\overrightarrow{N}$ are the correct principal atomic directions, except possibly for the extreme atoms **A** and **G** Assuming that **A** and **G**, **B** and **F**, **C** and **E** are equal within each pair, we obtain the results given in Table 3 (Lonsdale, Mason and Milledge, in preparation)

Table 3 PROBABLE RANGES OF VALUES OF INTERMOLECULAR AND INTRAMOLECULAR ROOT-MEAN-SQUARE VIBRATION AMPLITUDES FOR ANTHRACENE MOLECULES AT 290° K AND 95° K RESPECTIVELY

		t_L	t_M	t_N	φ_L	φ_M	φ_N
290° K	>	0 22	0 16	0 155 A	0 06	0 045	0 05 radians
	<	0 225	0 19	0 17	0 07	0 05	0 06
95° K	>	0 125	0 05	0 08 A	0	0	0 02 radians
	<	0 135	0 085	0 11	0 03	0 03	0 035

		$\mathbf{A}_L$	$\mathbf{B}_L$	$\mathbf{C}_L$	$\mathbf{D}_L$	$\mathbf{A}_M$	$\mathbf{B}_M$	$\mathbf{C}_M$	$\mathbf{D}_M$	
290° K	>	0 075	0 04	0	0	0	0 085	0	0 11	A
	<	0 085	0 045	0 03	0 03	0 07	0 115	0 09	0 155	

		$\mathbf{A}_N$	$\mathbf{B}_N$	$\mathbf{C}_N$	$\mathbf{D}_N$	
290° K	>	0 06	0	0 05	0	A
	<	0 09	0 03	0 075	0 05	

		$\mathbf{A}_L$	$\mathbf{B}_L$	$\mathbf{C}_L$	$\mathbf{D}_L$	$\mathbf{A}_M$	$\mathbf{B}_M$	$\mathbf{C}_M$	$\mathbf{D}_M$	
95° K	>	0 04	0 02	0 04	0	0	0 095	0	0 085	A
	<	0 055	0 04	0 055	0 02	0 085	0 105	0 06	0 11	

		$\mathbf{A}_N$	$\mathbf{B}_N$	$\mathbf{C}_N$	$\mathbf{D}_N$	
95° K	>	0 03	0	0 055	0	A
	<	0 10	0 03	0 09	0 07	

The t and φ values are similar to those of the compounds previously studied, but there are also striking intramolecular vibrations The large values of $\mathbf{B}_M$ and $\mathbf{D}_M$, combined with $\mathbf{A}_L$, point to an in-plane distortion which appears not to be markedly sensitive to temperature Similarly, the out-of-plane vibrations $\mathbf{A}_N$ and $\mathbf{C}_N$ are large at both temperatures, but $\mathbf{B}_N$ and $\mathbf{D}_N$ are not If $\mathbf{A}_M$ and $\mathbf{C}_M$ are related in phase, then some such movement as is shown in Fig 3 would result , but there is no proof that this particular interpretation of Table 3 is correct

A weakness of the method previously mentioned, which may be illustrated by naphthalene, is that there is as yet no way of deciding, on our simple model, whether the calculated value of (say) t_L should be reduced by k and the values of $\mathbf{A}_L$, $\mathbf{B}_L$, etc , all increased by the same amount Since $\mathbf{A}_L$, $\mathbf{B}_L$, etc , are not necessarily in phase, these would represent different vibration patterns Thus, the observed $\overline{u_L{}^2}$ and $\overline{u_M{}^2}$ for naphthalene can all be satisfactorily explained in terms of $t_L = 0$ 21 A , $t_M = 0$ 17 A , $\varphi_N = 0$ 072 radians, with $\mathbf{A}_L = \mathbf{A}_M = \mathbf{B}_L \quad = 0$ In the perpendicular direction, however, $\mathbf{A}_N$ and $\mathbf{C}_N$ are found to be about 0 11 $\pm$ 0 02 A , with $\mathbf{B}_N = 0$, implying an out-of-plane bending or puckering vibration of the molecule Our consistent practice has been to assume that, failing evidence to the contrary, the internal vibrations are zero

We recognize that the analyses we have illustrated here are over-simplified The major defect, that of an assumption of a spherical atomic scattering factor, is now being investigated in the light of the experimental data for graphite and hexagonal boron nitride. We do not believe that this source of error is eliminated by using only high-angle reflexions in the thermal analysis ; errors may even be introduced by this procedure.

Perhaps we can justify the simplicity of our approach by suggesting that if earlier workers had been inhibited, in their initial analyses of the structures of simple ionic compounds and of diamond, by their original neglect of refraction, dispersion, temperature vibrations, defect and disorder, the fundamental advances in crystal-structure analysis for which they were responsible would have been very much delayed.

We are most grateful to several colleagues for the use of intensity data prior to publication, or for original data published in a modified form ; and also for crystal specimens.

The calculations of atomic co-ordinates and *B*-factors basic to this article were carried out with the help of a grant for computing made from the Wellcome Trust, and with the use of tape-editing equipment purchased by means of a grant from the University of London Central Research Fund. Our thanks are also due to Messrs. Babcock and Wilcox, Ltd., for enabling us to use their Ferranti *Pegasus* computer.

One of us (K. L.) would like here to acknowledge personal indebtedness to the late Sir William Bragg for a training which emphasized that a simple approach to a difficult problem is not necessarily an inaccurate one.

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FLORAL MORPHOLOGY AND THE TAXONOMY OF EUCALYPTUS

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THERE has been, in recent years, a revival of interest in 'old-fashioned' comparative morphology as a tool in problems of taxonomy and phylogeny of Angiosperms[1]. Among the many groups in which conventional study of the morphology of the flower is still required is the large and important genus *Eucalyptus*, despite the fact that taxonomic relationships within this genus have been under fairly continuous scrutiny over the past 150 years. In this, as in certain other genera of Myrtaceae[2], the perianth parts are united to form one or two opercula which cover the flower until anthesis. Practically no reliable information is available concerning the structure and behaviour of the opercula in most species, and little use has been made of operculum characters in classification, apart from length and shape. Only one floral character has been used in delimiting most of the major categories within the genus, namely, the shape and mode of dehiscence of the anthers, and even here diversity has not been thoroughly exploited. No reference, for example, has ever been made to the presence of supernumerary glands (additional to the terminal gland) in the connective or on the anther lobes of certain species. Attempts have been made to produce a workable classification or deduce affinities between species using criteria such as bud and fruit shape, operculum length, shape, venation and glaucousness of leaves, cotyledon shape, and, more recently[3], seed anatomy. Such are the difficulties of the standard classification that, although this is put forward in what purports to be a 'key' to the genus[4], it is virtually impossible to use it as such ; its deficiencies are well known to many Australian botanists (see, for example, ref. 5).

Comparative studies on the anatomy of wood[6], bark[7], chromosome complements[8], and pollen grains[9] have not yielded information of much value to the taxonomist, principally because these studies have been inadequate in both extent and depth. Nevertheless, botanists and foresters have become familiar with the facies of the species (more than five hundred according to Blakely, but possibly reducible to between three and four hundred) and this has led to the establishment of certain groups ('series') some of which may be accepted as consisting of closely allied species and therefore 'natural'. Others of Blakely's series are clearly artificial, and a few species are so imperfectly known that their allocation to series is either intuitive or quite arbitrary.

One of the worst features of *Eucalyptus* taxonomy is that it is based largely on what may be termed 'shaggy dog' features, characterized by the qualification 'more or less', rather than on quantitative features, expressible numerically or by presence or absence. But more important still is the lack of fundamental concepts of the relationships between the series. The larger taxonomic units or 'sections' are still based primarily on Bentham's five anther classes[10], despite the fact that at least forty kinds of anthers, differing in size, shape, dehiscence, etc.[11], have been distinguished, and that many species are notoriously difficult to 'key out' by their anthers. Any classification based entirely on shapes which can vary[11] and which cannot be adequately described in words is bound to contain anomalies and, as Bentham was well aware, such a classification, based on a single feature, must be somewhat artificial.

The genus *Eucalyptus* is supposed to be distinct from *Angophora* in that *Angophora* has both petals and sepals free, whereas in *Eucalyptus* one at least of the perianth whorls is in the form of an operculum which is shed at anthesis. In fact, as we shall show, certain species have only a petaline operculum with or without sepals, and the others have two opercula, the outer, sepaline, operculum being shed either prematurely or with the inner one at anthesis.

(We understand that Mr. L. A. S. Johnson, New South Wales Herbarium, has reached conclusions which, in certain details, confirm our own.) In certain species the sepals remain small but free from each other and may persist even on the mature fruit. This condition of chorisepaly is found in species belonging to several of the groups which have evolved within the genus, although certain chorisepalous species, mostly grouped as series Eudesmieae, may be fairly closely related to each other. The Eudesmieae are characterized by the persistence of the sepals as small teeth and/or the grouping of the stamens into four bundles, opposite the petals, which are fused to form a single operculum. In the very young flower bud the sepals are large, relative to the other organs, but they soon cease growth and in the mature flower seem comparatively minute. Some of the species of Eudesmieae have both persistent, free sepals and grouped stamens (for example, *E. tetragona*), others (for example, *E. gamophylla*, wrongly placed by Blakely) have only the first of these characters, and other species again have no sepals but have the stamens grouped (for example, *E. baileyana*). (For *Eucalyptus*, Blakely's nomenclature (see ref. 4) is used throughout this communication. For related genera, the nomenclature is that used in ref. 9.) Microscopic examination of sections of the flower buds of the latter species has failed to reveal any trace of the sepals. In all species of *Eucalyptus* the inner and outer surfaces of both sepals and petals are covered by a cuticle which can be distinguished by the techniques of fluorescence microscopy[12]. In critical cases, as, for example, in *E. albens*, the presence of two opercula, closely adherent to each other, can be demonstrated only by fluorescence microscopy of thin sections of the mature bud, or by a study of the development of the flower bud (Fig. 1).

The species of the Eudesmieae may be arranged as a series in which the sepal primordia are progressively reduced in size until they are eventually suppressed altogether, thus leading to a condition in which only one perianth whorl (presumably the corolla) is formed. This condition is common to most, but by no means all, of the species included in the section Renantherae, and to all of those in the Renantheroideae. The species of Blakely's series Myrtiformes (section Renantherae), *E. deglupta*, *E. raveretiana* and *E. brachyandra*, have double opercula and should possibly be placed with the Exsertae (section Macrantherae).

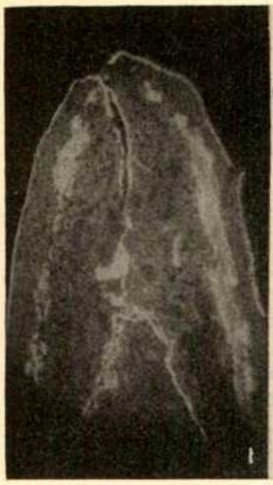


Fig. 1. Fluorescence photomicrograph (× 25) of a median longitudinal section of the tip of a mature flower bud of *E. sideroxylon*, showing fluorescence of cuticle on sepaline and petaline opercula and the cuticle-lined canal at the tip of the sepaline operculum. The canal in the petaline operculum is not seen in this section

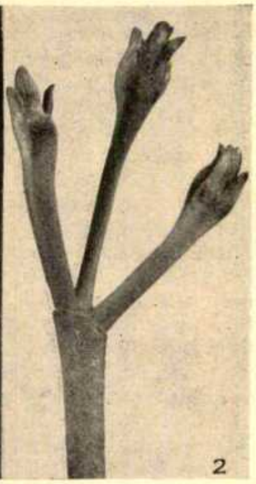


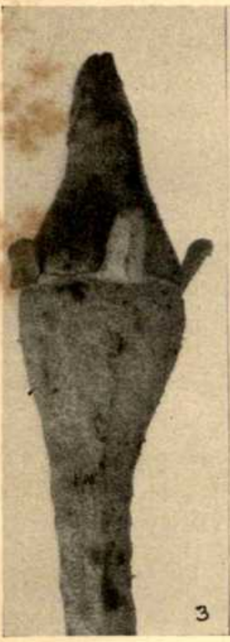
Fig. 2. Young inflorescence (× 1·5) of *E. steedmanii* after shedding of bracts. The sepals of the three flower buds are free and comparatively large

We have already shown that *E. microcorys* should be excluded on other grounds[13], and both it and *E. guilfoylei* should be placed with the Transversae. On the other hand, *E. jacksoni*, which has been confused with *E. guilfoylei* (they are ecologically associated and were both originally described from non-flowering material) should be placed in the Renantheroideae near *E. patens*, as suggested by Gardner[14].

Some of the species of the Macrantherae are mono-operculate (*E. preissiana* and *E. megacarpa* (series Globulares) and *E. miniata* and *E. phoenicea* (series Miniatae). If these species are to be grouped together with the renantherous species, the new arrangement would appear to cut directly across the system based on anther shapes. The species involved in this grouping, however, show every transition from the macrantherous condition (Miniatae) to the fully renantherous. Moreover, other characters such as the possession of stellate hairs by the juvenile foliage and, according to recent work[3], some of the characters of the seeds appear to be common to many of the mono-operculate species and uncommon in, or even quite absent from, species with double opercula. We have traced[13] the progressive increase in the number of flowers in the dichasial cluster from the Eudesmieae to the Renantherae, and in the degree of fusion of the bracts of the involucre, which never number more than six in the mono-operculate species. We propose to group these species in a sub-genus for which we suggest the informal name 'Monocalyptus'.

Although asepaly or chorisepaly is necessarily associated with a mono-operculate condition, it does not follow that all species in which the sepals are free from each other should be placed together, and Blakely's Eudesmieae may prove to contain some species unrelated to the others. Chorisepaly occurs in some other species but has not hitherto been recognized. The young flower buds of *E. steedmanii*, a species described in 1933, has sepals which are very large in proportion to the other organs. Although they remain free from one another, they become adherent to the petaline operculum as thick ribs with free recurved tips (Fig. 2). This species appears to be most closely allied to those of the series Dumosae. Free sepals are also present on the flower buds of *E. kruseana*, but they are delicately attached and are usually shed a little before anthesis (Fig. 3). This species is placed by Blakely in a highly artificial series, *Globulares*, but in its habit, foliage and cotyledon shape[15] it resembles *E. crucis* and should be placed near it.

The primordia of both sepals and petals arise in decussate pairs (in accordance with the basic phyllotaxis of *Eucalyptus*[16]) and the first formed pair of sepals and petals are generally larger than the other pair. Occasionally five sepals are formed. Apical growth of the sepal primordia soon ceases and further enlargement takes place either by zonal growth, in which the bases of the sepals are united to form a tube, or by separate intercalary meristems. In the former case a sepaline operculum is formed, while the latter results in chorisepaly, the length of the



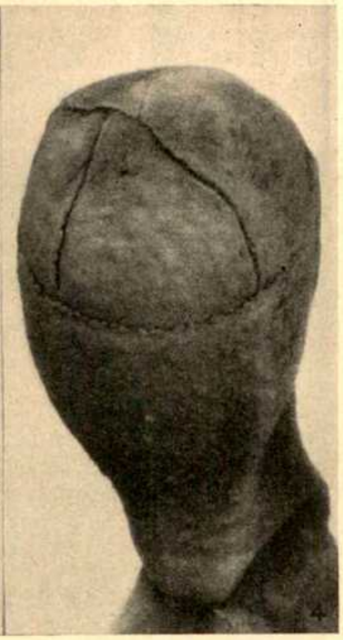


Fig. 3. Flower bud of *E. kruseana* showing the free sepals (× 20)

Fig. 4. Flower bud of *E. guilfoylei*, seen from above to show the abscission scar of the sepaline operculum and the sutures of the petals, which form the petaline operculum (× 10)

sepals depending on the extent of intercalary growth. In all cases, at least the tips of the sepals remain free from each other and the tips of the petals are also free. Thus the tip of each operculum is traversed by a cuticle-lined canal. The limbs of the sepals may also be free from each other to an extent depending on the delay in initiation of the circular meristem at the base of the sepal primordia. In *E. pyriformis*, for example, the sepals are free from each other for about one-third their length (compare ref. 17), but die and are shed when the flower buds are about 1 cm. long. In a few species the sepals are free from each other but undergo abscission when the flower buds are less than 2 mm. long (for example, *E. brachyandra*, *E. raveretiana* and *E. microcorys*. The sepals are then either shed or, if they remain adherent to the petaline operculum, wither and are torn into fragments during its growth.

In certain species, for example, *E. microcorys*, *E. guilfoylei* (Fig. 4), *E. raveretiana* and *E. curtisii*, post-genital fusion of the margins of the petal primordia is delayed and the lines of fusion of the petals are clearly visible on the mature flower bud; in these species the petals are readily separable with a dissecting needle. In *E. erythrocorys*, in which the petals are all equal in size, the sutures are conspicuously thickened. In at least a few species of the Corymbosae (for example, *E. ficifolia* and, contrary to Willis[18], *E. gummifera*) the petals are not even post-genitally fused and are actually separate in the mature bud, although adherence to the sepaline operculum causes them to be shed with it as part of a single cap.

In immature flower buds the absence of a sepaline operculum may be surmised from the absence of the scar or line which, in species which lose the outer operculum precociously, usually indicates its former line of junction with the petaline operculum; but this criterion must be used with considerable caution. Certain species (for example, some of those in the Corymbosae) retain both opercula until maturity, and others may lose the sepaline operculum when the flower buds are still enclosed in the involucre and so small that no scar is later visible. In *E. lehmanni*, for example, it is necessary to examine buds no more than 1–2 mm. long in order to see the sepaline operculum, which has then ceased to grow. Each flower is sessile and grows through the outer operculum, leaving its disorganized remnants attached to the 'common receptacle' of the inflorescence. This species belongs in the series Cornutae, one of the more obviously natural groups[19], and related species also lose a sepaline operculum early in development, though none so precociously as *E. lehmanni*.

Also deceptive are the four-angled flowers of species such as *E. tetraptera*, which has been placed near the Eudesmieae on the supposition that the tips of the four angles of the calyx-tube represent free sepals. In fact, *E. tetraptera* loses a sepaline operculum in early development[20] and the 'tetrapterous' condition may be merely the result of compression of the young flower bud between its bracteoles (as in *E. globulus*, which loses its sepaline operculum relatively late, and *E. forrestiana*) and is, in any event, not a character common among chorisepalous species. *E. tetraptera* should be placed with the mallees (series Dumosae) which it resembles in its general habit, leaves and cotyledons and stamens.

Relatively few species retain both opercula until anthesis and they are placed in widely separated sections. Some of them comprise the series Corymbosae (bloodwoods) after the removal of the species grouped as the Clavigerae (Maiden) S. T. Blake[5] and, with the exception of *E. jacobsiana*, which is incorrectly placed by Blakely, of the yellow bloodwoods (*E. eximia*, *E. torelliana*, *E. peltata*, *E. bloxsomei*, *E. watsoniana*), all of which lose the sepaline operculum at an early stage in flower development. The yellow bloodwoods (in the restricted sense used above) should be grouped at least as a separate series, for which we suggest the name 'Eximieae'. It has already been suggested[5] that the Clavigerae may not be so closely related to the Corymbosae as has hitherto been thought, and the same suggestion may now be raised concerning the Eximieae. However, other characters (for example, the caoutchouc-like cuticle) peculiar to the bloodwoods (and found also in some species of *Angophora*) may indicate affinities despite the differences in behaviour of the sepaline operculum.

Certain species of the section Terminales also retain both opercula until anthesis. Many of them are placed in the series Siderophloiae which is, however, quite heterogeneous. Most of the species of the supposedly related Heterophloiae lose the sepaline operculum before the flowers reach maturity. The species in this section and in the heterogeneous section Porantheroideae–Normales are among the most 'difficult' in the genus and, as the mode of loss of the outer operculum (which we have found to be constant for a given species) can be readily determined from unopened buds on herbarium specimens, type specimens should be re-examined critically in order to clear up some of the taxonomic muddles. Due warning should be given, however, of the necessity of examining thin sections with the aid of the microscope.

In the majority of species with two opercula, the sepaline operculum is shed either at a very early stage in flower development or at least well before maturity of the bud. This group includes Transversae, Cornutae and Subcornutae, Dumosae and

Exsertae, which are all fairly natural series of the section Macrantherae. It also includes sections Macrantherae–Normales, Graciles, Micrantherae and Platyantherae, a large and heterogeneous group. It is here that the main problems of *Eucalyptus* taxonomy now lie, and further criteria are required to elucidate relationships. To this end we have collected a considerable amount of information on the presence or absence of oil glands in the filaments and of supernumerary glands on the connective or anther lobes, characters which have either not been recorded or not deemed worthy of more than casual reference. In the Cornutae and Dumosae, for example, the filaments have oil glands and there are supernumerary glands on the connective or anther lobes of many of the species of these series, which are probably quite closely related to each other.

While the nature and behaviour of the perianth in *Eucalyptus* remained obscure, comparisons with supposedly distinct but related genera, such as *Angophora*, *Pleurocalyptus* and *Cleistocalyx* were difficult to make and the distinctions between *Eucalyptus* and these genera seemed clear. Both *Cleistocalyx* (*Acicalyptus*) and *Pleurocalyptus* have a sepaline operculum and free petals, which are adherent and are shed together as a cap. This cap often remains attached to one side of the open flower bud. The petals are fringed and highly glandular. All these characteristics are shown by certain members of the Corymbosae. The ovary of *Pleurocalyptus* is semi-superior, as is the ovary in certain species of *Eucalyptus*, for example, *E. deglupta*, *E. raveretiana*. Again, the similarities between the vegetative characters of *Angophora* and those of some species of *Eucalyptus* are striking; the resemblance between *E. jacobsiana* and *E. setosa* and certain species of *Angophora* is remarkable. It is tempting to suppose that *Eucalyptus* has had a polyphyletic origin and that *Monocalyptus*, in particular, has developed quite independently of the rest of the genus.

We wish to thank the Government botanists of Victoria and New South Wales for allowing us access to the State Herbaria. Our thanks are due also to many foresters in Victoria and colleagues at Melbourne for collecting specimens, and to Mr. E. A. Matthaei and Mr. R. Oldfield for assistance with microscopy and photography.

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VARIOUS TYPES OF ACQUIRED RESISTANCE TO EXPERIMENTAL 'ALLERGIC' ENCEPHALOMYELITIS

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IN our previous communications[1,2] two facts of acquired resistance to experimental allergic encephalomyelitis have been reported, namely, (*a*) after recovery from the conditions and (*b*) after immunization with a mixture of the non-encephalitogenic brain of an embryo or new-born rabbit with the adjuvant.

Prior to our work, three other facts of induced resistance to experimental allergic encephalomyelitis have been described: (1) Ferraro and Cazullo[3] inoculated a mixture of monkey brain with paraffin oil and lanolin (without mycobacteria) in 15 daily doses to guinea pigs. On the fourth day after the last inoculation, the animals were treated with the encephalitogenic mixture. Out of 12 animals, 1 contracted the disease compared with 12 or 13 in the control. (2) Condie *et al.*[4] reported resistance in rabbits 45 days after immunization with homologous spinal cord. (3) Lumsden[5] reported resistance after inoculation with non-encephalitogenic mixtures of an alcohol extract of the brain or adrenals with the adjuvant and suggested that the resistance was called forth by the adjuvant.

Following our publication, Kies and Alvord[6] confirmed Lumsden's suggestion. These workers suggest that in our experiments acquired resistance has been induced by the adjuvant, in particular, by the killed tubercle bacilli.

Our evidence confirms that immunization with the adjuvant alone can indeed account for a certain amount of resistance to experimental allergic encephalomyelitis, but as regards its morphology and mechanism it is to be distinguished from the resistance acquired after recovery from the condition or after immunization with a mixture of embryo brain and the adjuvant.

Experimental proof is adduced below that there are various types of acquired resistance to experimental allergic encephalomyelitis. These types of resistance can be understood from consideration of that acquired by animals after recovery from experimental allergic encephalomyelitis, which makes doubtful the allergic nature of the condition itself. Prior to our experiments, this fact has not been described in the literature, in which even quite opposite results can be found[6]

In the following experiments a somewhat modified technique from that previously described[1,2] has been used a total challenge dose of 1 ml of the encephalitogenic mixture was injected subcutaneously to guinea pigs simultaneously in 5 loci in doses of 0 2 ml In most of the experiments large animals (500–1,000 gm) were used, since they have been found to be particularly susceptible to experimental allergic encephalomyelitis

In the first experiment, 53 guinea pigs were repeatedly treated 1–9 months after recovery from experimental allergic encephalomyelitis with the encephalitogenic mixture Only one case of disease was recorded as against 78–100 per cent in the controls The acquired resistance following recovery could not be transmitted passively via the blood and the cells of the lymphatic nodes and spleen[9]

In the next series of experiments guinea pigs were immunized two to three times with various ingredients, and after 3–6 weeks were challenged with the encephalitogenic mixture

Guinea pigs immunized with a mixture of the brain of new-born rabbits with the adjuvant proved resistant to experimental allergic encephalomyelitis The disease incidence was 0/31 in the experiment and 32/37 in the control (86 per cent) (Here and below the denominator indicates the number of animals in the experiment, and the numerator the number of individuals contracting the disease) After challenge, in the cerebrum of the animals with resistance acquired after recovery from experimental allergic encephalomyelitis and after immunization with a mixture of brain of new-born rabbits with adjuvant there was found the pathomorphological picture of experimental allergic encephalomyelitis without demyelinization along with complete clinical health

The disease incidence among the guinea pigs immunized with the adjuvant alone varies from 0/31 to 4/9 (44 per cent) compared with 32/37 (86 per cent) and 14/18 (77 per cent) in the controls However, in the central nervous system of guinea pigs which have acquired resistance through immunization with the adjuvant alone, no changes have been noted either prior to challenge or after it This resistance apparently does not involve the central nervous system, being merely 'peripheral' This is a resistance to the effect of the adjuvant or, more precisely, to the peripheral mechanisms of induction of experimental allergic encephalomyelitis but not to experimental allergic encephalomyelitis itself which develops in the central nervous system

No resistance has been achieved through immunization with a 50 per cent suspension of the brain of new-born rabbits *per se* or with lanolin and paraffin oil, or with large doses of killed B C G *per se* (200 mgm doses twice in 5 loci) or with lanolin and paraffin oil

Daily injections for 15 days of 0 2 ml of a mixture of adult rabbit brain with lanolin and paraffin oil (Ferraro and Cazullo's method[3]) ensured resistance to the administration of the encephalitogenic mixture on the fourth day after completion of the injections, namely, 2/10 (20 per cent) in the experiment as compared with 7/9 (77 per cent) in the control

The next experimental series suggests the existence of acquired resistance to experimental allergic encephalomyelitis of the interference type Guinea pigs were injected daily for 16 days intraperitoneally or subcutaneously with 3 ml of a 20 per cent cerebral suspension of adult rabbits without adjuvant Between the sixth and seventh injections they were treated with an encephalitogenic mixture The disease incidence in the experiment was 3/16 (18 per cent) and 8/11 (72 per cent) in the control No interference effect was observed on inoculation according to the same scheme (1) with the brain of new-born rabbits , (2) with large doses of killed B C G (16 doses of 250 mgm) , (3) with lanolin and paraffin oil We could not confirm our suggestion[1,2] as to the presence in the brain of new-born rabbits of a factor responsible for the development of resistance to experimental allergic encephalomyelitis and different from the encephalitogenic factor

We could not distinguish the antigens of rabbit embryo brain from the brain of adult rabbits in the anaphylaxis reaction with desensitization, using Zilber's method[8,9]

Multiple daily subcutaneous and intraperitoneal injections of large doses of adult rabbit brain also prevent the contraction of experimental allergic encephalomyelitis when they are started simultaneously with the administration of the encephalitogenic mixture

Moreover, daily 20 intraperitoneal injections of 5 ml of 25 per cent adult brain suspension, started 5 days after the injection of the encephalitogenic mixture, completely prevent experimental allergic encephalomyelitis (0/13 in the experimental group as compared with 12/15 in the control one) Even if treatment with massive doses of the cerebral suspensions started at a later date, it checked the disease

In some experiments single or two-fold intracerebral inoculation of brain emulsion of adult rabbits interfered with the effects of the simultaneous or previous administration of the encephalitogenic mixture

The following types of acquired resistance to experimental allergic encephalomyelitis can be tentatively distinguished (1) acquired resistance of the central type (recovery after the disease, immunization with the brain of new-born rabbits with adjuvant) ; (2) resistance of the interference type (administration of the cerebral substance shortly before or after administration of encephalitogenic mixture) , (3) resistance of the peripheral type (administration of the Freund adjuvant)

We have found recently in the progeny of guinea pigs treated during pregnancy some signs of experimental allergic encephalomyelitis[8–10] This progeny at the age of five months had evidenced some degree of resistance of the disease

We acknowledge the technical assistance of I S Keeselova and E A Kamigina

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[10] Svet-Moldavsky, G J , and Svet-Moldavskaya, I A (to be published)

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 14

Institution of Electrical Engineers (at Savoy Place, London, W C 2), at 5 30 p m —Discussion on "Why Hi-Fi?", opened by Mr P P Eckersley

Society of Chemical Industry, Pesticides Group (at 14 Belgrave Square, London, S W 1), at 5 30 p m —Mr P B Cornwell "Insect Control by Gamma Irradiation"

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 8 30 p m —Baron G de Gerlache de Gomery "The Belgian Antarctic Expedition"

Tuesday, December 15

Institute of Marine Engineers (at the Memorial Building, 76 Mark Lane, London, E C 3), at 5 30 p m —Mr K Maddocks "Some Aspects of Marine Reactor Security"

Institute of Physics (at 47 Belgrave Square, London, S W 1), at 5 30 p m —Mr K G Freeman "Tubes for Colour Television"

Institution of Electrical Engineers, Measurement and Control Section (at Savoy Place, London, W C 2), at 5 30 p m —Discussion on "Data Handling Problems in Atomic Installations", opened by Dr D Taylor

Wednesday, December 16

Powder Metallurgy Joint Group of the Iron and Steel Institute and the Institute of Metals (in the Hoare Memorial Hall, Church House, Great Smith Street, London, S W 1) at 9 30 a m —Symposium on "The Powder Metallurgy of Magnetic Materials"

Royal Meteorological Society (at 49 Cromwell Road, London, S W 7), at 5 p m —Dr H Wexler "Seasonal and other Temperature Changes in the Antarctic Atmosphere", Mr W Hitschfeld "Patterns of Hailstorms in Alberta"

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 5 15 p m —Sir Hugh Beaver, K B E "Statistics as a Tool of Management" (Presidential Address)

Institute of Petroleum (at 61 New Cavendish Street, London, W 1), at 5 30 p m —Mr A C Hartley "Pipelines"

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S W 1), at 6 p m —Dr S G Hooker "The Future of Air Breathing Engines in Aviation" (James Clayton Lecture)

Society of Chemical Industry, Corrosion Group (at 14 Belgrave Square, London, S W 1), at 6 p m —Discussion of Research Papers recently published by Members of the Group

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W 1), at 7 p m —Mr J F Coales "Random Inputs and Load Variations"

Thursday, December 17

British Computer Society, London Branch (at the Northampton College of Advanced Technology, St John Street, London, E C 1), at 2 30 p m —Discussion on "Conversion between Analogue and Digital Representation"

Society of Chemical Industry, Road and Building Materials Group (at 14 Belgrave Square, London, S W 1), at 2 30 p m and 5 30 p m —Scientific Papers

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Dr A J Robinson "Relationship Between Particle Size and Collector Concentration", Mr D Borchers "Deepening of No 1 Vertical Shaft at Premier (Transvaal) Diamond Mining Co , Ltd "

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Prof E V Schenkman "Supersolvable Groups"

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, London, W C 2), at 6 p m —Discussion on "The Presentation of the History and Philosophy of Science", opened by Prof H Dingle

Thursday, December 17—Friday, December 18

Physical Society (in the Townsend Lecture Theatre, The Clarendon Laboratory, Oxford), at 10 a m daily—Conference on "Electron-Phonon Interaction in Solids"

Friday, December 18

Society of Chemical Industry, Fine Chemicals Group (at 14 Belgrave Square, London, S W 1), at 6 30 p m —Dr F E Camps "Some Aspects of Forensic Science"

Friday, December 18—Saturday, December 19

British Psychological Society (at University College, Gower Street, London, W C 1)—Conference

Saturday, December 19

Biochemical Society (in the Department of Chemical Pathology, King's College Hospital Medical School, Denmark Hill, London, S E 5), at 10 30 a m —389th Meeting

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Assistant Lecturer or Lecturer in Physics—The Secretary, The University, Exeter (December 19)

Assistant Lecturer or Lecturer in the Department of Zoology—The Registrar, The University, Liverpool (December 19)

Shepherd Research Fellow in the Department of Pathology, for work on immunological problems of ocular disease—The Director, Department of Pathology, Institute of Ophthalmology (University of London), Judd Street, London, W C 1 (December 31)

Scientific Officer (with a good honours degree in botany and experience in plant physiological research) in the Botany Department, to work on physiology of growth and yield of the sugar beet, particularly on the causes of variation between places and seasons in field crops—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (January 1)

Assistant Lecturer or Lecturer in Physics—The Registrar, University College of South Wales and Monmouthshire, Cathay's Park, Cardiff (January 2)

Assistant Lecturer or Lecturer (with an honours degree or equivalent, and preferably experience in hydraulics) in the Department of Fluid Mechanics—The Registrar, The University, Liverpool (January 4)

Lecturer in Biblical Archæology at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, January 4)

Research Fellows (2) in the Department of Geography, Research School of Pacific Studies, Australian National University, Canberra—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, January 4)

Research Fellow (with a good knowledge of electronics) in the Department of Physics, to engage in a research programme on spark discharges, in association with Prof J M Somerville—The Registrar, University of New England, Armidale, N S W , Australia, or The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (January 9)

Chair of Physiology in the University of Malaya (Singapore Division)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (January 15)

Lecturer or Assistant Lecturer in Pharmaceutics at the University of Malaya (Singapore Division)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (January 15)

Chair of Chemistry—The Registrar, University College of Wales, Aberystwyth (January 16)

Lecturer or Assistant Lecturer in Physiology—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (January 16)

Lecturer/Senior Lecturer in Mechanical Engineering at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, February 2)

Assistant Director of the Meteorological Department, Ghana—The Director of Recruitment, Ghana High Commissioner's Office, 13 Belgrave Square, London, S W 1

Assistant Lecturer and Demonstrator in Physics—The Secretary, Queen Elizabeth College (University of London), Campden Hill Road, London, W 8

Irrigation Officer (with a university degree in agriculture, or a science degree with agricultural experience, and training or experience in soil physics or irrigation) in Swaziland, to carry out irrigation experiments on sugar cane, citrus and other crops, and to take charge of a new experimental station—The Director of Recruitment, Colonial Office, London, S W 1, quoting Ref BCD 63/76/014/C1

Research Assistant (with an honours degree in electrical engineering or physics) in the Department of Engineering, for an investigation of certain aspects of the high current vacuum arc—The Secretary, The University, Old College, South Bridge, Edinburgh

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University of Birmingham Report of an Enquiry into the Suitability of the General Certificate of Education Advanced Level Syllabuses in Science as a Preparation for Direct Entry into First Degree Courses in the Faculty of Science Pp v+212 (Birmingham The University, 1959) [221

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO, LTD,
ST MARTIN'S STREET, LONDON, W C 2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare London

Annual subscription £7/15/–, payable in advance,
postage paid to any part of the world

Advertisements only should be addressed to
T G Scott & Son, Ltd , 1 Clement's Inn, London, W C 2
Telephone Number Holborn 4743

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IMPACT OF SCIENCE AND TECHNOLOGY ON HUMANISM

IN an outstanding oration, "A Balance Sheet for Science and Technology in Europe", delivered before the Conference of European University Rectors and Vice-Chancellors at Dijon on September 9, Sir Eric Ashby examined the proposition that twice in history European civilization has been one fabric, and twice in history the fabric has been torn; science and invention have contributed to its destruction, but in science and invention lies our hope for its repair. The early fabric of European society which the barbarian invasions destroyed was, Sir Eric pointed out, one in which the constant diffusion of ideas produced "a singularly uniform and cosmopolitan civilization throughout the Roman world from which the local and provincial spirit was strikingly absent". Under the impact of these invasions the common language decayed, traffic between the centres of culture diminished, the channels of communication between university and university, city and city, became overgrown and stagnant and Europeans became provincial.

When the traffic of ideas again revived, it was not, however, a traffic between institutions or corporations but a traffic between individual scholars, and the directing influence was no longer theology or the Church, but the New Philosophy and the phenomena of Nature. In the seventeenth and eighteenth centuries, science became one of the threads which held together the fabric of European civilization. A traffic which began between individuals became consolidated in the interchange of publications between scientific societies and academies, and in the nineteenth century science became established in the universities; and the universities began to regain their lost prestige in European life and have once again become centres of high intellectual energy in Europe. Sir Eric rightly stressed the importance of their intercommunications, and especially of those channels of communication which lie in science.

Turning to consider the balance sheet of science in Europe, Sir Eric rejected the view that science is the prime cause of the fear which over-shadowed contemporary life, that science can be held responsible for destroying craftsmanship and cheapening taste, or that mass production and mass communication have made Europe decadent and vulgar. Mankind, he reminded his audience, has always lived in fear, and it is only the sophisticated who suffer from a sense of doom. Again, while science and invention have changed standards for the rank and file of Europeans, the new standards have practically all been improvements; only the sophisticated show a sense of frustration, and that because, while millions are happier through the achievements of technology, they themselves are no longer able to believe in progress.

From such considerations Sir Eric argued that we should not measure the impact of science and invention on Europe by the sophisticated standards of university professors. For the common citizen of Europe, science and invention have neither increased the level of fear nor led to a decay in standards. In drawing up a balance sheet for science in Europe, fear and decadence should not be included on the debit side.

Nevertheless, there are ambivalent effects. For example, improvements in communication have proved of dubious benefit. Indeed, air travel has actually weakened some traditional bonds of understanding; the aeroplane has debased the art of diplomacy and in some ways has initiated the cohesion of Europe. Similarly, in spite of much on the credit side, the effects of mass media have a heavy debit too.

On the credit side of the balance sheet for science in Europe, Sir Eric put first the new interdependence which unites the scientific laboratories of Europe as closely as the cathedrals and priories and abbeys of medieval Europe were united. The clear and undisputed benefit which science confers on Europe, and indeed on the whole literate world, is that it deals in universals. Secondly he put a common faith in science which is shared by thousands of Europeans, and which could become a foundation from which they can explore and understand their differences. The scientists, moreover, are united not only by a common faith but also by obligations to a common faith. Thirdly, Sir Eric put the destruction by the scientific revolution of what he called the tyranny of dogmatic truth, and its replacement by a formula for tolerating error in others. Truth is now tentative, not final and revealed, and it is an integral part of the scientific tradition that this formula does not permit a man to tolerate what he has come to see are errors in his own thinking; it permits him only to tolerate what he believes to be errors in the thinking of his colleagues.

There is indeed substance in Sir Eric Ashby's contention that if there is to be cohesion in Europe, nothing is more necessary than a formula for tolerating error; nor does he exaggerate when he maintains that the scientists and other scholars of Europe comprise a coherent group preserving their national differences but sharing common beliefs and aspirations. It is a precious asset, too, that universities, since they are the chief centres of scholarship in Europe, are united by science into one pan-European community. Nevertheless, the hope for Europe depends upon cohesion among whole populations of Europeans, not solely among a handful of university teachers, and Sir Eric did well to remind us that, in spite of modern universal education, the common man to-day is less in touch with what is best and most significant in European civilization than his ancestors were five centuries ago.

If science is to make its potential contribution to European cohesion, the common man must be helped to understand something of the objectivity, the humility and the tentativeness which characterize a scientist when he is thinking about science This we have, in spite of the mass media, so far conspicuously failed to do, and in the concluding passage of his oration Sir Eric Ashby made several practical suggestions regarding the interpretation of science• Frequently, he believes, such failure is the fault not of the mass media as such but of the interpretation itself, which has been ill-designed for the purpose to be served , and like others he directed attention to the dangers attendant on the immense prestige of science even when the work of the scientist is not understood It must be recognized that science has its failures as well as its successes, that it too has its limitations, and as a small practical contribution to the interpretation of the values of science to the ordinary man, Sir Eric made the sound suggestion that much more could be made of the essential part played by technicians, craftsmen and instrument makers

Here undoubtedly there is a link between science and the non-scientist, and an opportunity to enlist the interest of the man who works with his hands and to convince him that he is not just a spectator, but an essential actor, in the modern scientific age Quite apart, moreover, from that possibility, greater attention to the place and work of the technician and craftsman could have most valuable results in other ways, for the consequent fuller understanding could in turn help the more effective use of scientists and technologists themselves and assist in maintaining a better balance in trained man-power Such considerations should not be overlooked by the universities, and it is to them that Sir Eric Ashby turns in particular for more effective interpretation of science to the common man This, he suggests, is a task for which they should assume greater responsibility and the execution of which they should study intensively He believes that they have here a unique opportunity for influencing the history of Europe, such as has not been theirs since the fourteenth century Like Sir Solly Zuckerman, he emphasized the embarrassing dependence of the decisions of governments on scientists and technologists, many of whom are based upon universities If the universities were able to interpret to the common man the invisible forces which are thus shaping mankind, he believed they could make a notable contribution to the restoration of the fabric of Europe

Sir Eric Ashby did not attempt to indicate further how this task should be undertaken, but it clearly enhances both the regional responsibilities of the universities and puts their extra-mural work in a fresh perspective There are implications, too, for the use and development of the mass media which need urgent exploration , but Sir Eric was careful to disclaim any suggestion that science alone would solve Europe's problems Science can help to spread goodwill and tolerance, but in so doing it is only reinforcing an older and deeper faith the faith of men in mankind

It will be noted that Sir Eric did not suggest that this task of interpreting science so that it can make its full contribution to international cohesion is solely the responsibility of the universities, although he stressed the uniqueness of their part Other institutions have also a part to play, and some of the opportunities were clearly present in Dr A T Waterman's mind when he addressed a Conference for Executives in Federal Science Agencies at Williamsburg on September 14 on science and international affairs Dr Waterman was primarily concerned in this address with the manner in which international scientific activities are organized, but while he stressed the dependence of national security and welfare upon science, he also emphasized the way in which science itself grows and develops without reference to national boundaries

Much of the interest of Dr Waterman's address lies in his account of what the National Science Foundation, of which he is director, is doing to foster international co-operation in science and the interchange of scientific information , but, like Sir Eric Ashby, he referred also to the important part which the scientific societies and learned bodies themselves have to play Dr Waterman, reiterating Dr L V Berkner's comment that such co-operation is still very young and is best conducted by scientists themselves, pointed out the local character of certain kinds of research , and since they arise in a particular place in a particular way, the results cannot be applied universally Dr Waterman, however, was pleading for adequate support for such research from other regions, quoting tropical diseases and antarctic weather conditions, whereas Sir Eric referred to the ecology of alpine vegetation and was illustrating the way in which a narrow definition of the humanities could draw a distinction harmful to scholarship

Nevertheless, Dr Waterman, like Sir Eric Ashby, directs attention to the need for greater knowledge and better understanding both on the part of scientists and of those who serve their country abroad Laymen in all fields should be much more literate with respect to science than in the past, and Dr Waterman urged that universities should be encouraged to include special courses in science for non-scientists Indeed, much more is already being done in that field in the United States than would appear from Dr Waterman's remarks, and both the National Science Foundation and the Science Adviser to the Secretary of State have been active in that field

Even closer to the trend of Sir Eric Ashby's oration is the fifth Dunn Memorial Lecture delivered before the Society of Chemical Industry by Sir Alexander Fleck last May Opening with a tribute to Dr J T Dunn as scientist and humanist, whose life worthily reflected that great concept of humanism which is one of the glories of our Roman heritage, Sir Alexander expounded his view of science and humanism as a background to citizenship Like Sir Eric Ashby, he protested against a narrow definition or conception of humanism, and urged that the humanities must include the great peaks of imagination of the human mind, even if, like the

"Principia" and "The Origin of Species", their subject-matter belonged to science. While science itself is concerned mainly with fields external to man, Sir Alexander rejected the idea that scientists tend to be both lacking in humanity and incapable of appreciating the humanities.

Sir Alexander quoted Einstein's assertion, "Concern with man and his fate must always be the chief aim of scientists"; but although he obviously shares the same comprehensive view of science as Sir Eric Ashby, he did not elaborate on how such a scholarly and objective study of Nature, including man and his works, could become a new cement of civilization. He sought rather to show how the relevance of science and humanism to citizenship could find expression in practical ways. The scientist, he observed, cannot contract out of an interest in human affairs. Neither scientist nor humanist, if versed only in his narrow specialized subject, could expect to see the significance of his work in the widest human context.

Such practical contributions as Sir Alexander described clearly have their own indirect contribution to make to the interpretation of science to the ordinary citizen in the sense indicated by Sir Eric Ashby. Moreover, in its turn the task of interpretation, and perhaps especially that part of it to which Sir Eric summons the universities, has its own practical implications in another way. Both Lord Weeks, speaking as 'special visitor' at the Imperial College of Science and Technology on October 22, and Mr. H. Wilmot, in his fifth Elborne Memorial Lecture to the British Institute of Management on October 30, have recently spoken of the demands made to-day for leadership, and the way in which the universities can help to meet that need.

Lord Weeks, for example, referred to the intangible qualities of mind and personality required to make a man acceptable as a leader, to the call for high intellectual capacity and wide vision as well as for the capacity to understand the latest advances and discoveries of science and technology. Mr. Wilmot formulated even more precisely the nature of the demands made to-day upon those who carry the responsibility of positions of high authority in industry and commerce, and indicated how the universities would increasingly be expected to help provide a continuous supply of those capable ultimately of filling such office. More specifically, Lord Weeks indicated the implications for our educational system of a demand for leaders with such breadth of learning without incurring a debasement of standards.

Lord Weeks was confident that the Imperial College and other universities and colleges of Great Britain can meet this demand; but clearly this is a task to which further thought must be given. Our conceptions of both science and humanism must be sound, and every effort must be made to close that dangerous cultural gap of which Sir Charles Snow has given emphatic warning. Moreover, in the measure in which the universities are the better equipped to provide leaders of imagination of vision and character as well as of intellectual ability and technical skill, they may find it the easier to discharge the responsibility for the interpretation of science to the common man. However that function may be best fulfilled by the universities, whether directly or indirectly, whatever new techniques may be applied, however limited or generous a view is taken of extramural or regional responsibility, a university can scarcely address itself to the task at all unless, within its own walls, the gap is closed, and science has demonstrated its cohesive power and is already binding together a community of scientists and other scholars.

MAN-MADE DRUGS

May's Chemistry of Synthetic Drugs

Revised and rewritten by Dr. G. Malcolm Dyson, in consultation with Dr. Percy May. Fifth edition. Pp. vii+678. (London: Longmans, Green and Co., Ltd., 1959.) 110s. net.

DURING the twenty years that have passed since the last edition of this book our knowledge of synthetic drugs has increased out of all recognition, particularly in the fields of the antibiotics, antimalarials and sulphonamides, where work was stimulated by their military importance.

This has necessitated the re-writing of the whole book. In doing so, the authors have rightly decided to classify the drugs according to their biological activity rather than by their chemical structure.

Though the high standard set by the sensible and well-balanced views on structure and activity relationships expressed in the early chapters is maintained throughout, it is a pity that the reader is not brought quite up to date. The historical background to the various sections is excellent and useful, but some of the more recent work is not included. This point is well brought out by a study of the references. In "Metabolism of Drugs" (Chapter 2) the latest reference is Dittmer and du Vigneaud (1947), while, with the remarkable exception of Borrisov (1994) (*sic*), the most recent reference cited in the discussions on structure and activity is dated 1945. Seventeen of the forty references at the end of this latter chapter were published in the past century.

This fact in no way detracts from the authors' treatment of the subject but serves to illustrate the need for a book of this kind to be written by a panel of authors, each able to give a really up-to-date account of his own particular field. Many of the omissions are possibly due to the same cause. No mention is made of methyl pentynol in the chapter "Sedatives and Hypnotics", or of the oral hypoglycæmic agents—for example, sulphonyl ureas, or the oral diuretic chlorothiazide.

The section dealing with penicillin contains some serious errors. On p. 611, the acid hydrolysis of penicillin is said to produce penicillic acid, instead of penillic acid. Penicillic acid is correctly described elsewhere in the same chapter. In the description of the synthesis of penicillin V on p. 615 the yield for the cyclization of the β-lactam ring is quoted as 75 per cent. The actual figure should be 10–12 per cent; 75 per cent is the yield for the removal of the *t*-butyl group in the previous stage. No mention is made of the important property of acid-stability exhibited by penicillin V. That "it is not known whether valine, cysteine and phenylacetic acid are biochemical precursors of penicillin" is not true in the light of the work by Dr. Arnstein and his collaborators.

In spite of these minor criticisms, the book is well laid out and well printed. Workers in the field of synthetic drugs will sympathize with the authors' problem of how to deal with the many trivial names of a single drug. Though perhaps not bringing the reader quite as up to date with the subject as he might wish, this book will, nevertheless, prove invaluable as a reference work to those interested in the chemistry and activity of synthetic drugs.

F. R. BATCHELOR

MICROBES ON THE MOVE

Biochemical Engineering

Unit Processes in Fermentation. Edited by Dr. R. Steel. Pp. 328. (London: Heywood and Co., Ltd., 1958.) 50*s*. net.

Progress in Industrial Microbiology

Vol. 1. Edited by Dr. D. J. D. Hockenhull. Pp. viii+248. (London: Heywood and Co., Ltd., 1959.) 50*s*. net.

SINCE the advent of the commercial production of antibiotics in the 1940's, the application of micro-organisms to industrial purposes has been given a new stimulus, which has more than compensated for the declining importance of fermentation processes for the production of such materials as alcohol, acetone and butanol under the impact of the petrochemicals industry.

These two publications represent the first attempt in Great Britain to collect within a reasonable compass some of the vast store of information in this field. As such they will be welcomed by all whose pre-occupation with a particular aspect limits their view of the horizon.

Steel's book is based on a series of lectures given in Manchester in 1957 by a panel of speakers, who, for the most part, have considerable experience in research or in the industrial applications of microbiology. Its scope is limited essentially to the fermentation industries, which cover only part of the activities of the biochemical or biological engineer. This is clearly seen by comparing the coverage of this volume with the topics mentioned in the introductory chapter on "The Scope of Biochemical Engineering". Only one chapter is contributed by chemical engineers practising in this field, and this is concerned largely with mechanical engineering design. Its title is, therefore, a misnomer. Nevertheless, it provides an introduction to a field in which chemical engineers are likely to be increasingly involved. Indeed, its very limitations should act as a stimulus to a more forthright chemical engineering approach. The book will also serve to give those entering this field some notion of the problems and approach of the biochemist and biologist, and of the multifarious activities of the ubiquitous microbe.

The second book, from the same publisher, is the first volume in what promises to be a valuable series. The topics chosen represent a good balance between the more academic approach of the 'pure' microbiologist and biochemist on one hand, and the needs of microbiological technology on the other. The balance is maintained in the chapters on the tetracyclines, microbial fat and riboflavin synthesis. The editor himself contributes an authoritative review of the influence of the constituents of the medium on the biosynthesis of penicillin, and pays a well-deserved tribute to Dr. Bisset for his "lucid and beautifully illustrated article" on the saprophytic Actinomycetes. Finally, an article on microbiological assay not only surveys the common laboratory techniques but also includes a section on statistical analysis, showing clearly the influence of this approach in the actual operation of the assay laboratory. The standard set by this volume, and the list of topics mentioned for review in forthcoming volumes, should ensure a wide and continuing interest in the series.

N. BLAKEBROUGH

THE PERIODIC LAW

Periodic Law

By D. I. Mendeleieff. Edited by B. M. Kedrov. Pp. 830 (Russian text). (Moscow: Acad. Sci. U.S.S.R., 1958.) 33 r.

THIS valuable and substantial volume containing Mendeleieff's publications relative to the Periodic Law represents a publication quite independent from Mendeleieff's "Scientific Archives" reviewed in these columns in 1955 (*Nature*, 176, 965; 1955), the first volume of which was published in 1953, while the second and the third volumes remain as yet unpublished. The present volume belongs to the series "Classics of Science" and is apparently entirely due to the initiative and labour of B. M. Kedrov, assisted by the late T. N. Chentzova.

The first section of the book contains reprints of fifteen "Principal Articles" by Mendeleieff relating to the Periodic Law. Actually the first item of this collection is not an article at all but a copy of the first issue of the Periodic Table (March 1, 1869). Besides this copy the book contains a large number of photographic and printed reproductions of different variants of the Periodic Table.

The second item in this collection is the first article of Mendeleieff dealing with the Periodic Law published in the *Journal of the Russian Chemical Society* (1, pp. 60–77; 1869). This is followed by a number of shorter articles and then by the Russian text of the German article entitled "Die periodische Gesetzmassigkeit der chemischen Elemente" published in *Liebigs Annalen*, 1871, Supp. VIII, Heft 2, pp. 133–229. Extracts from this article were published by W. Crooks in the quarterly *Journal of Science*, No. 55, (1877), and a full translation in the *Chemical News*, 40 (1879), and 41 (1880). According to Mendeleieff himself, this article presented "the best summary of my views and arguments on the periodicity of the elements and was the main text used for the numerous comments on this system. This article was the main cause of my renown as a scientist". Short papers on peroxides follow with others on the atomic weight of yttrium, the cerium group of metals, gallium and the rare metals. Number thirteen is the Russian text of the Faraday Lecture entitled "The Periodic Law of the Chemical Elements". The lecture was delivered by Mendeleieff on May 23/June 4, 1889, before the Chemical Society in London (*J. Chem. Soc.*, 55, 634; 1889). The remaining items are an article from the Russian Encyclopædia of 1898, and an extract from the "Principles of Chemistry", 1906 edition.

The section entitled "Additions" contains a miscellaneous collection of Mendeleieff's articles of lesser importance, notes, letters and extracts from books, all of them related to the Periodic Law The items in this section are arranged in groups labelled *A* to *J* Briefly their contents are (*A*) collection of periodic tables and other tables of various dates (1869–1906) as they appeared in the successive editions of the "Principles of Chemistry" , (*B*) extract from the first edition of the "Principles" (1870–71) , (*C*) a group of three articles, one from *Le Moniteur Scientifique*, 9, 691 (1879) , and two from *Berichte d chem Ges* , 4, 348 (1879) and 13, 1796 (1880), dealing with the history of the Periodic Law and the controversy with Lothar Meyer , (*D*), (*E*) and (*F*) are miscellaneous extracts , (*G*) extracts relating to the discovery of the inert gases and radioactivity (1895–1905) , (*A*) a collection of various items including the Russian text of the lecture read on May 19 and 31, 1889, at the Royal Institution in London, and entitled "An Attempt to apply to Chemistry one of the Principles of Newton's Natural Philosophy" (*Chemical News*, 40 (1889) , (*I*) miscellaneous extracts , (*J*) extracts from Mendeleieff's earlier works (1855–61) relating to the preparatory work in connexion with the future discovery of the Periodic Law

The last section of the book is entitled "Supplements" (pp 675–825) It contains a varied assemblage of very valuable editorial notes, commentaries, bibliographical and biographical data, two coloured reproductions of Mendeleieff's portrait and a very interesting article by B M Kedrov, "The Periodic Law of Mendeleieff and the World's Science"

S I TOMKEIEFF

X-RAY POWDER METHODS

The Powder Method in X-ray Crystallography

By Prof Leonid V Azároff and Prof Martin J Buerger. Pp xv+342 (London McGraw-Hill Publishing Company, Ltd , 1958) 68*s*

THE appearance of this authoritative work on the X-ray powder method is very welcome It is more compact than some other works that have been produced recently, but is nevertheless exhaustive enough for most research workers, and the extensive references give ample guidance for further reading

The exposition of basic ideas bears the clear mark of experienced and thorough teaching , the stress laid upon the reflexion concept in Bragg's treatment of X-ray diffraction is particularly noteworthy since so many text-books gloss over this important point The book also contains ample experimental detail and advice on various techniques to help both the beginner and the more experienced student The section on interpretation and indexing is particularly good

The only adverse criticism that might be made is that the book tends to lay down American practice as final and complete There are several points in which practice differs from that in Great Britain, and the American practice is not always as logical as it is made to appear in this book For example, cameras in Britain are 9 and 19 cm in diameter , in the United States they are 5 7 and 11 4 cm Although there is some arbitrariness in the former figures, they were designed to give films just less than 30 cm in length since comparators of 30 cm were readily available The American radii give a simple number of millimetres per degree , but the reviewer has never met anyone who makes use of this property for rough work one uses *d* scales directly, and for accurate work film shrinkage must be allowed for

Secondly, the Americans use the Straumanis design because the camera does not need to be calibrated But this design is rather awkward, and the calibration of cameras is not particularly difficult Certainly the Straumanis design does not lead to higher accuracy , the authors claim 2–4 parts in 10^5 as a limit, but Bradley and Jay were achieving this accuracy in 1932

Thirdly, the Americans make considerable use of accurately fitting slides, whereas British cameras use kinematic supports Consequently, the former need individual supports for each camera, whereas kinematic design allows for much more flexibility

These points, however, merely indicate that the subject is a living one, in which there are still many points of divergence between different practitioners The book can be thoroughly recommended

H LIPSON

GLOVE BOXES AND SHIELDED CELLS

Glove Boxes and Shielded Cells for Handling Radioactive Materials

A Record of the Proceedings of the Symposium on Glove Box Design and Operation held in the Cockcroft Hall, A E R E , Harwell, February 19–21, 1957 Edited by G N Walton (Sponsored by The United Kingdom Atomic Energy Authority, Harwell) Pp. xii+515 (London Butterworths Scientific Publications , New York Academic Press, Inc , 1958) 95*s* , 16 80 dollars

AS one of the authors remarks, one of the most difficult problems facing the worker with radioactive materials is to decide what degree of protection is appropriate to his particular circumstances The introductory chapters of this book provide useful basic data and discussions of principles, which should be helpful in determining a logical and realistic policy for the use of glove boxes The fundamental requirements of radiological protection have not changed appreciably since this Conference was held in 1957, but the reader should bear in mind that controls have tended to become more stringent meanwhile, particularly in the higher ranges of activities

For alpha emitters and the more toxic isotopes generally, complete containment of the material in a glove box or similar enclosure is essential The majority of the papers in this symposium are concerned with this aspect, and together they form an extensive review of practice which is now fairly well established. Many aspects of design are covered by contributors with first-hand experience of them, such as materials for construction, radioactive decontamination, filtering systems and the use of inert atmospheres The papers are mainly drawn from experience within the U K Atomic Energy Authority, but there are also some excellent reviews of practice in the United States and other countries The techniques described here are for use with radioactive materials, but they may also be of interest in connexion with other work where critical control of environment is necessary, as in dust-free or aseptic procedures

For isotopes which emit penetrating radiations the operations become much more complex, as shielding must be superimposed on the requirement of containment. The choice of system, whether it should be tongs in shielded boxes or manipulators in cells, is correspondingly more difficult. The second part of the book is concerned with such problems, and it contains a lot of useful data for design as well as practical experience in dealing with highly active materials up to the 1,000 MeV curie level. It refers particularly to work with fission products and irradiated metallurgical specimens. This part is necessarily rather less satisfactory than the first, because these techniques are at present developing more rapidly than those for handling alpha emitters.

The book is well produced, and one appreciates the heavy task of the editors and publishers in attaining this result. Nevertheless, there is much to be said in favour of adopting a simpler, cheaper and quicker form of publication for the proceedings of symposia such as this one.

MATRIX ALGEBRA IN STRUCTURAL ANALYSIS

Linear Structural Analysis

An Introduction to the Influence Coefficient Method applied to Statically Indeterminate Structures. By Prof. P. B. Morice. Pp. xii+170. (London: Thames and Hudson, Ltd., 1959.) 35*s*. net.

ONE of the most important advances in the theory of elastic structures during the past few years has been the development of matrix methods of analysis. This work has been considerably stimulated by the advent of automatic digital computers, since these machines are very well suited to the manipulation of large matrices.

Methods of structural analysis may be divided into two groups. The first, often termed 'equilibrium' or 'stiffness' methods, consider joint displacements as the basic unknowns, and proceed by setting up and solving the equations of joint equilibrium. The second group, known as 'compatibility' or 'flexibility' methods, attack the problem in terms of the redundant forces and moments in a structure, determining these by equations of displacement compatibility.

Prof. P. B. Morice's book is entirely devoted to the second of these two approaches. He commences by discussing general energy theorems, influence coefficients and indeterminacy. The treatment of the latter subject follows recent work by Henderson and is extremely thorough. The central section of the book presents a short account of matrix algebra and the associated numerical techniques, described from the point of view of a human computer using a desk calculating machine. After this the flexibility coefficient method of analysis is presented in matrix notation, with examples of its use in particular cases. The book concludes with a brief account of the way in which matrix work can be carried out on a *Pegasus* computer.

The development of matrix methods of structural analysis is by no means complete, and the theoretician will doubtless find that many of the ideas presented in this book are capable of further generalization and extension. Although the conciseness and generality of matrix notation are well displayed, there are several places where unusual symbols (such as x and n for force vectors) make the text more difficult than it might have been for a newcomer to the subject. There are also a few misprints which suggest rather hurried proof reading.

From the short title on the cover, and various paragraphs in the preface and introduction, the reader with a limited knowledge of structural analysis might well assume that the best, if not the only, way of using matrices in structural analysis was by means of the flexibility methods described in this book. The book would have been a very much more valuable one if it had contained a parallel account of the equally important stiffness methods of analysis, with demonstrations of the relative merits of the two approaches in a number of examples.

R. K. LIVESLEY

THE GEOLOGICAL DEVELOPMENT OF NORTH AMERICA

The Evolution of North America

By Dr. Philip B. King. Pp. xvii+190. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1959.) 60*s*. net.

THE publication of a book which collates and interprets the considerable number of available facts concerning the regional geology of North America can be expected to be a notable event when the author has the background of Dr. P. B. King, with wide and long experience in the United States Geological Survey and interests covering tectonics, stratigraphy and physical geology. The story of the growth of the northern part of the American continent is not treated chronologically but regionally, with emphasis on selected areas of the United States. Although the book arises from lectures to graduates, the author explains that it is not a text-book in the usual sense; prominence is given, however, to 'Reference Material', a list of maps and books, which receives precedence over 'Contents' and is supplemented by 'References' (which are not referred to in the body of the text) at the end of each chapter.

After an introductory chapter addressed mainly to the layman, the Canadian Shield is treated in broad outline. When he turns to consider the Interior Lowlands, Dr. King is able to draw on his personal experience of field work in the West Texas Basin, and in the chapter on the Appalachians his close acquaintance with the complexities is evident. Valuable comments on geosynclines and the growth of the Appalachians, stemming from earlier publications by the author, are followed by examination of modern analogues of geosynclines around the Gulf of Mexico and the Caribbean. The second half of the book examines the mountain chains and intermontane regions in the west, largely in the United States. The complex subdivisions of this belt are clearly outlined and interesting notes and anecdotes concerning its exploration are included.

The geological maps and sections are admirably executed, and the sketches by Trudy King above chapter headings add a pleasing touch. The typography can only be criticized in details; sub-headings tend to become obscured in the text and the list of contents (pp. xi–xiv) suffers from lack of variation in fount and insufficient indentation of sub-headings.

Dr. King succeeds, with a fresh and stimulating approach, in outlining a great deal of the structural framework of North America but is only partially successful in fulfilling the promise implied by his title with respect to historical geology.

J. W. COWIE

Advances in Electronics and Electron Physics

Vol 10 Edited by L Marton, assisted by Claire Marton Pp x+320 (New York Academic Press, Inc , London Academic Books, Ltd , 1958) 10 dollars

A DIVERSITY of subjects has always been a feature of previous volumes of the series of reports on "Advances in Electronics and Electron Physics" (the last three words having been added after Vol 5) Papers on physical effects and on the preparation and properties of materials have been freely intermingled with others describing the methods of designing, making and using devices and with theoretical analyses The tenth volume is no exception , indeed, the diversity may be thought to be excessive Thus, the paper on the logical organization of computers, well written though without recourse to a single diagram or mathematical expression, is perhaps too remote from another which analyses electron flow in magnetically focused cylindrical beams and which is unlikely to attract the attention of anyone not engaged in designing or using micro-wave valves Three papers should be widely approved The first deals with defects in crystals of semiconductors with the diamond lattice, a subject which has benefited from the availability of large crystals of germanium and silicon The second shows how micro-wave engineers have adapted, and can still further adapt, techniques from optics The third describes recent progress with the design of cathode ray oscilloscopes (Is this the one remaining use of the words 'cathode ray' ?) Partly because their early role of presenting recurrent wave forms has long been extended to transient phenomena, and they are easy to use, these flexible instruments are now found in almost all branches of science, and a few of the arts, and their design, capabilities and limitations deserve the widest recognition The sixth paper, on the reliability of valves, can for the most part be appreciated only by valve engineers, but the sections dealing with reasons for failure and action to improve life are of more general interest J R Tillman

Second Symposium on Coal Preparation, Department of Mining, University of Leeds

21st to 25th October, 1957 Pp xii+513 (Leeds The University, 1959 Distributed by the Coal Preparation Plant Association, 301 Glossop Road, Sheffield 10) 20*s*

COAL preparation may be regarded as a collective term for those processes, mainly physical and mechanical, to which coal may be subjected in order to make it suitable for specific use These processes include hand cleaning, hand selection, blending, screening, breaking, crushing, pulverizing, wet cleaning, dry cleaning, de-dusting, dust proofing, drying, de-watering, froth flotation and briquetting Aspects of several of these processes were discussed at a Symposium held at the University of Leeds, the proceedings of which contain eighteen papers, a detailed record of the discussions on each paper and summaries of rapporteurs on each of the four groups of subjects in which the papers may be classified

The subjects dealt with range from trends in the pattern of coal preparation to traffic control and wagon marshalling at colliery and coal preparation sidings, and include size distribution equations, sampling, problems of moisture and moisture retention in coals, aspects of certain processes—including dense-medium cleaning and stratification in jig washers, principles and practice of froth flotation, washery water, testing and performance of coal preparation plants, and briquetting

There is a balanced combination between the various papers of basic principles, research and industrial practice The publication is a valuable addition to the literature of coal preparation

S G Ward

A History of Western Technology

By Friedrich Klemm Translated from the German by Dorothea Waley Singer Pp 401+24 plates (London George Allen and Unwin, Ltd , 1959) 32*s* net

THIS is a book of much interest, but its title is misleading It is in fact an anthology consisting of 219 passages on technological topics selected from contemporary writings Since inventors and engineers have not always written about their work or writers concerned themselves with contemporary technological developments, a history based solely on original writings must appear somewhat defective and unbalanced The compiler, who is the librarian of the Deutsches Museum, Munich, has therefore attempted to give a continuous account by supplying connecting passages and an introduction to each chapter

The extracts are chosen with the view of depicting the atmosphere in which technological advance took place rather than describing the technology itself Owing to the lack of earlier material the story only begins with ancient Greece , and, on the other hand, the treatment of the past hundred years is very selective and brief

The reader is offered much interesting material which he may not know of or trouble to translate for himself Thus there is Filarete's description of a visit to an ironworks in 1464, the extracts from the proceedings of the Nuremberg Council in relation to the inconvenient inventiveness of two of the red-metal turners living there in the second half of the sixteenth century, and the observations of Fischer, Schinkel, Beuth, and Harkort, German visitors to Britain in the nineteenth century The book is well illustrated with 59 line drawings and 24 half-tones

K R Gilbert

Principles of Geochemistry

By Prof Brian Mason Second edition. Pp viii+310 (New York · John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1958) 68*s* net

THE second edition of this excellent introduction to geochemistry follows the same general lines as the first, but although no major changes have been made, changes in detail are numerous Many of the data in the first edition have been replaced where possible by the more reliable figures that have become available during the past six years, and results of recent work have been incorporated in the text The number of tables and text-figures has been increased and the bibliographies at the end of each chapter have been revised and brought up to date A new and welcome feature is the introduction of two appendixes, one giving atomic weights, atomic numbers and ionic radii of the elements, the other giving a geological time-scale

This is a useful text-book for students, and it is unfortunate that the price has had to be increased to such an extent S R Nockolds

THE BOTANIC GARDENS, SINGAPORE, 1859–1959

By H M. BURKILL

Director, Botanic Gardens, Singapore

IN this year of significance in the political history of Singapore, the Botanic Gardens at Singapore celebrate the centenary of their founding Centenaries are in the air and they are in good company their elder sister at Kew has just observed a bicentenary, Kuala Lumpur, the capital city of the Federation of Malaya, in which and for which territory these Gardens have done so much of their work, has this year attained its century, and, if one might stretch a biological association, so has the Guinness Brewery

The present Gardens are the last of three The first were set up by Sir Stamford Raffles in 1822, when the East India Company settlement was but three years old These lasted until 1829 when, on a false notion of economy, they were abandoned They were resuscitated in 1836 by an Agri-horticultural Society which ran them until 1846 In 1859 another Agri-horticultural Society with official blessing took possession of land which is now a part of the present Gardens

The intention behind all these Gardens was to foster and encourage the agriculture of the fast-expanding Colony The first Gardens introduced and grew possible economic crops, but chiefly nutmegs, cloves and cacao The second Gardens managed to recoup its expenses on the sales of nutmegs and cloves Though the intention of the 1859 Agri-horticultural Society was also to give encouragement to local agriculture, it set about first creating a pleasure garden Perhaps this was an economic necessity in order to attract membership, for membership carried privileges After the pleasure garden got under way, the superintendent, Lawrence Niven, who designed and carried out the landscaping, was able to turn his attention to growing fruit, vegetables and flowers for distribution to members

The Society soon found itself in financial difficulties, and bit by bit Government assistance became a bigger item in its budget In 1869, at the invitation of the Committee, the Government appointed a representative to the Committee and increased its contribution on condition the Society exhibited living specimens of economic plants In order to add popular attraction, a zoo was established in the Gardens at this time, which lasted until 1905 Finally, in 1874 the Committee requested the Government to take over the Society's assets and liabilities and to run the Gardens out of public funds The Government agreed, and from January 1, 1875, to this day the Gardens have been an official department

This change in management brought with it a change in purpose The Government sought to broaden the scope of work to include a study of the flora of the Malay Peninsula, and instructed the committee of management to obtain the services of a botanist who was also a practical man Henry James Murton was engaged and arrived in Singapore in 1875 In the five years he was superintendent, until 1880, when he was dismissed for neglect of duties, he achieved much, but mainly what interested him He greatly extended the range of plants grown in the Gardens, he corresponded and exchanged with other Gardens, he travelled in the Malay Peninsula and began a herbarium, he drafted in manuscript a Flora of Singapore Perhaps the most significant of his works was his handling of the first *Hevea* seedlings to be established in Singapore and Malaya in 1877, the progeny of which in very large measure have stocked the plantations of south-east Asia He also established many other plants of possible economic importance, and in 1879 he began planting in the land to the north of the Gardens, later known as the Economic Garden and now part of the grounds of the University of Malaya

Nathaniel Cantley followed Murton, arriving in Singapore in 1880, but he soon became sick and his subordinate, Walter Fox, was left in charge, as he was during the interim between Murton's departure and Cantley's arrival Cantley returned in 1881, and in the next year the Government commissioned him to survey the forests of the Straits Settlements As a result, a Forest Department was formed with Cantley as its head and with officers in the three settlements of Singapore, Penang and Malacca, and later in the Dindings Cantley planted an arboretum in the Economic Garden to have on hand local trees To these he added exotics In the Gardens he made great changes in layout and arranged the planting according to taxonomic classification In 1887 his health broke down and he died

The appointment of Henry Nicholas Ridley in 1888 as director marked the opening of another chapter in the history of the Gardens He was a man of tremendous energy and capacity for work, and even though he had an admirable foundation to build on, he pushed the Singapore Botanic Gardens to the forefront of international botany His interests were manifold A brief biography by J W Purseglove was published in *Nature*, 176, 1092 (December 10, 1955) on the occasion of his hundredth birthday Ridley travelled far and wide in Malaya and in the region His collecting was prodigious and he advanced the knowledge of the Malayan flora to such an extent that when he wrote his "Flora of the Malay Peninsula" (published 1922–25) after his retirement, it filled five thick volumes of 2,948 pages During the earlier part of Ridley's directorship the Gardens continued to administer the forests of the Straits Settlements, but a separate Forest Department was set up in 1901 The Gardens work on economic crops grew, and agriculture in Malaya developed to such an extent that a separate Agricultural Department was established in 1904, but the Gardens continued to publish an agricultural periodical, begun in 1891, until 1912 (*Agricultural Bulletin of the Malay Peninsula*, 1891–1900, *Agricultural Bulletin of the Straits and Federated Malay States*, 1901–12)

Perhaps the most spectacular work of the Gardens during Ridley's time was that on rubber. When Ridley arrived he found nine mature trees, some fifty which were 2–4 years old, and more than a thousand seedlings. Ridley experimented on means for their exploitation, persisting even in the face of official disapproval. His tapping technique remains fundamentally unchanged to this day. The Gardens planted *Hevea* in forest clearings and on waste ground, so that when the planting rush came at the beginning of this century the Botanic Gardens was the only major source of supply of seed. Up to 1917, when the Gardens ceased selling seed, more than 7 million had been distributed. Though *Hevea* holds the limelight, the Botanic Gardens have been responsible for the introduction and distribution of many other economic crops.

With Ridley's retirement in 1912, Isaac Henry Burkill, who had been adviser on economic botany to the Government of Bengal, came as director. The First World War hampered development and limited staff, but interest in plants of economic value was maintained. The Agricultural Department naturally held the established economic crops within its purview, but the Gardens continued to be a source of supply of many. A list of plant material available for sale dated 1916 had 200 species, but the loss of the Economic Garden in 1924 for the building of a college for higher education meant the end of this work. During his directorship, I. H. Burkill travelled much, particularly after the war years, and amassed a great quantity of data on native uses of plants. He specialized on *Dioscorea*, native medicines cultivated plants and ethnobotany.

At the end of the First World War, T. F. Chipp was appointed assistant director and he extended the work of the Department to the Cryptogams (fungi); but he soon transferred to West Africa. R. E. Holttum was appointed to the vacancy in 1922, a condition of the appointment being that he should study a group of plants different from that covered by the director. Holttum began a study of the ferns, which he has made a life-work, and now in retirement he is preparing a monograph of the ferns for "Flora Malesiana", a work which will take him perhaps ten years to accomplish.

In 1924 the Gardens benefited by the cessation of botanical work at the Perak Museum at Taiping, and M. R. Henderson joined the staff as curator of the Herbarium. The Perak Museum Herbarium followed him to Singapore and was incorporated with the Singapore Herbarium in 1926.

I. H. Burkill retired in 1925 and at once commenced to write "A Dictionary of the Economic Products of the Malay Peninsula", which eventually took him ten years to complete. Unfortunately, only 2,000 copies were printed and it has long been sold out. Such is its value to all tropical botanists and agriculturists that it is hoped to reprint it.

With the surrender of the Economic Garden in 1925, the Botanic Gardens lost its immediate contact with economic agriculture and forestry, and the work became more concerned with ecology, taxonomic botany and horticulture. In the last field, under the

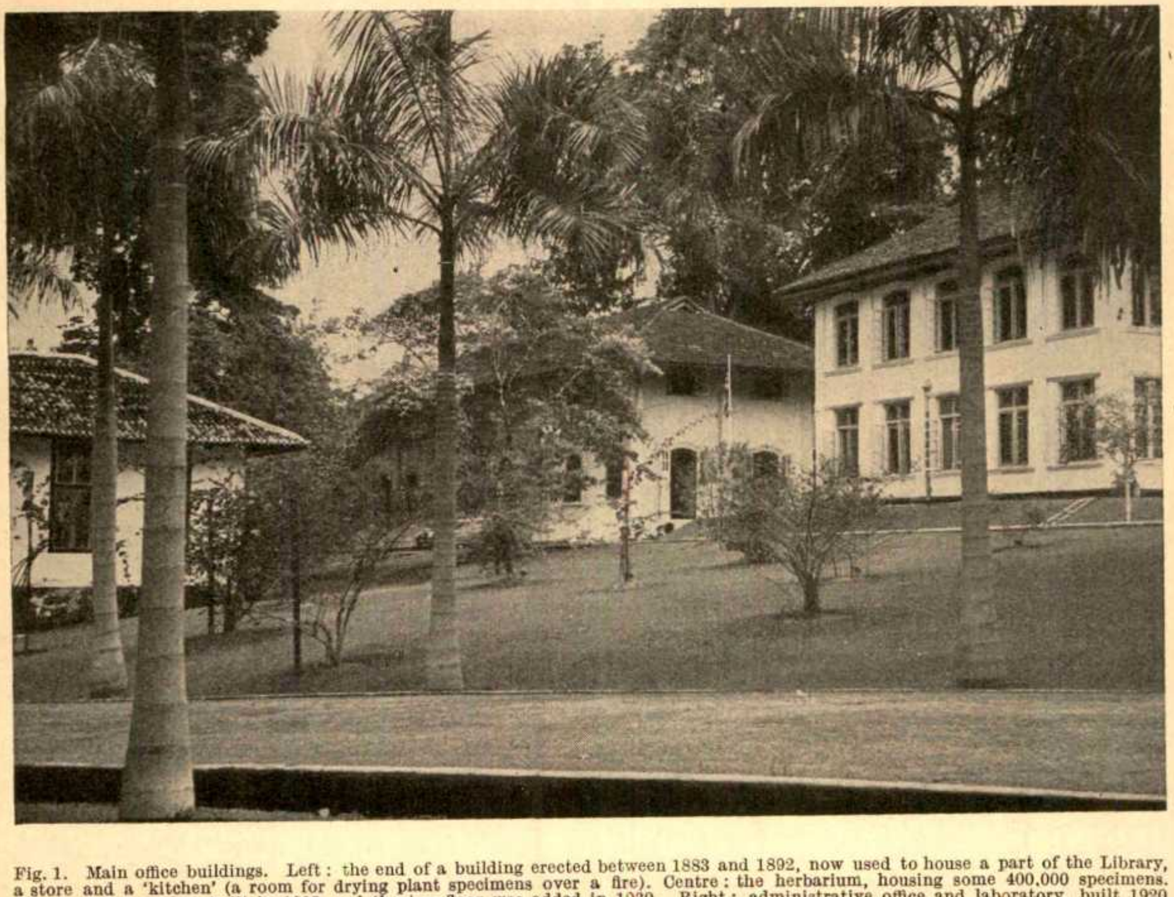

Fig. 1. Main office buildings. Left: the end of a building erected between 1883 and 1892, now used to house a part of the Library, a store and a 'kitchen' (a room for drying plant specimens over a fire). Centre: the herbarium, housing some 400,000 specimens. The ground floor was built in 1903, and the top floor was added in 1930. Right: administrative office and laboratory, built 1920

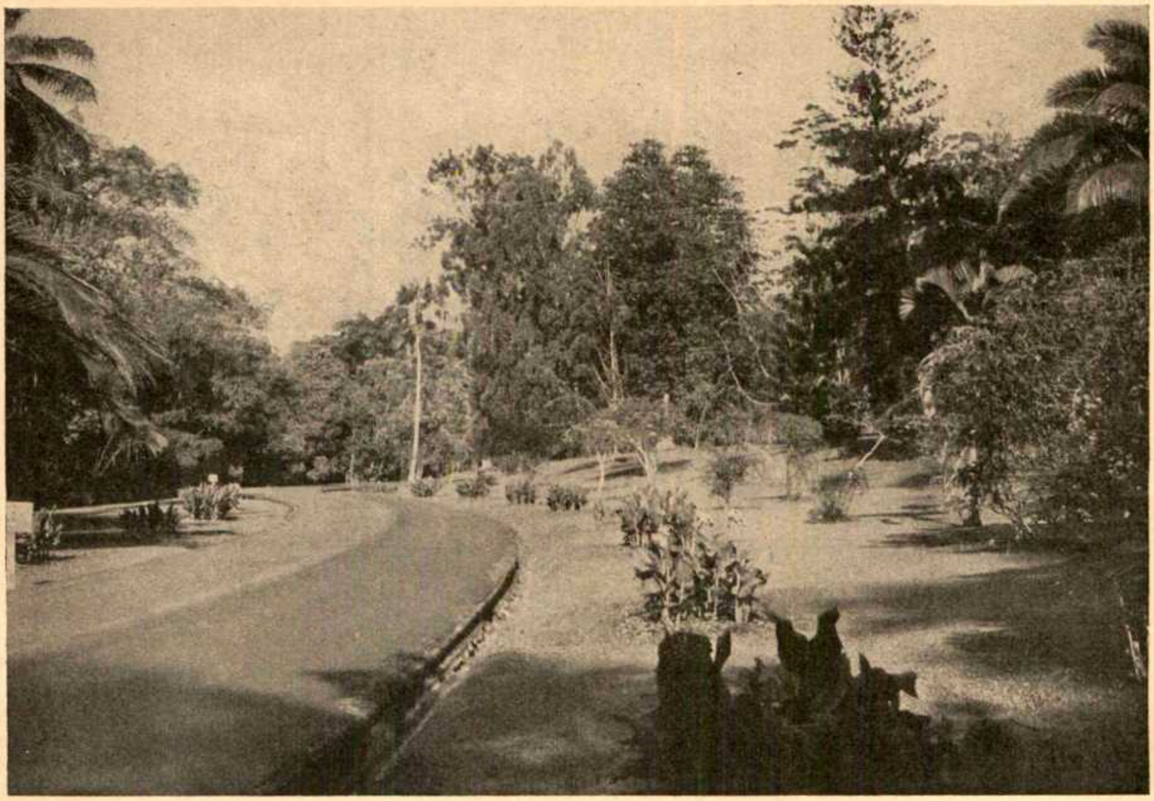

Fig. 2. Gardens from inside the main gate. Beds of hybrid cannas flank the road. To the right are collections of bougainvilleas, conifers and casuarinas

directorship of Holttum, a programme of hybridizing was begun, particularly with orchids, which has continued to this day with undiminished vigour. This work has given rise to a thriving orchid nursery industry with an increasing export trade and to an extremely active band of amateur orchid fanciers and breeders throughout Malaya.

In the botanical field, Holttum worked not only on ferns but also on bamboos, gingers and, naturally, on orchids. Henderson specialized on the limestone flora of Malaya, Myrtaceae and *Callophyllum*. He wrote "Malayan Wild Flowers" in two volumes, which was published by the Malayan Nature Society. E. J. H. Corner, who joined the staff in 1929, worked on fungi, trees and ecology, and especially on the genus *Ficus*. C. X. Furtado, who came in 1923, studied palms, aroids and other groups of monocotyledons. Specialist work of the Botanic Gardens was thus well diversified and had in addition the benefit of collaborators such as Carr (orchids), Foxworthy (F.M.S. Forest Department, forest trees), and many others. This period of increased taxonomic study continued up to the outbreak of the Second World War and is recorded by a not insubstantial run of issues of the Botanic Gardens periodical, *The Gardens' Bulletin*.

With the restriction of botanical work during 1942–45, the Botanic Gardens were indeed extremely fortunate to have been sent from Japan successively Profs. Hidezo Tanakadate, of Tôhoku Imperial University, and Kwan Koriba, of the Imperial University of Kyoto, as director. No loss was suffered in the Library or in the Herbarium, thanks to their efforts. Holttum, Corner and Furtado were retained to work in the Gardens, and it was perhaps some compensation that Holttum and Corner, relieved of administrative and executive responsibilities, were able to devote their almost undivided attention to revision and preparation of monographs. There is no doubt that this break afforded Holttum the opportunity which otherwise would not have come to him, perhaps until after retirement, to prepare draft manuscripts for Vols. 1 (Orchids) and 2 (Ferns) of the "Revised Flora of Malaya", which were published after the War ; "It is an ill wind . . .". It is significant that, like Holttum, both Ridley and I. H. Burkill completed their major literary works after the close of their official careers.

The post-war years have been marked by shortage of staff. This and the state of terrorism in the Federation of Malaya have severely limited botanical exploration. But now more extensive field-work is possible. Greater use is being made of subordinate staff on plant-collecting assignments. Trained Malayan personnel for appointment in both the botanical and horticultural sections of the Gardens is now available, and there is prospect for regaining a full establishment. This is essential so that the Department may add its vital contribution to the economic development of Malaya and the region. The field is immense. Current estimates for the compilation of "Flora Malesiana", in which project the Botanic Gardens is a major collaborator, run into decades. The achievements of the Gardens' first century have been impressive, but the field for the second century paradoxically is increasing. The more we learn, the more we find we have yet to learn.

INTERNATIONAL OCEANOGRAPHIC CONGRESS

IN spite of the increasing application of scientific discoveries to development of weapons and to enhance national prestige, we can still maintain that science is one of the most international of intellectual activities, and hold that anything we can do to promote co-operation is likely to contribute to better understanding between nations If not generally true, it must still be so for the study of the oceans, with its very wide and numerous bearings on human welfare, and it seems very appropriate that the first International Oceanographic Congress, which took place during August 31–September 11, should have been held in the United Nations headquarters in New York , also that it should be sponsored by the American Association for the Advancement of Science, which has ably demonstrated the part science can play in raising the level of economic prosperity, and by Unesco, which strives to spread the educational, cultural and practical benefits to all nations Oceanographers have a tradition of working together, and have a number of intergovernmental councils and scientific associations to help them, but this was probably the first time such a grand attempt had been made to assemble enthusiasts from every aspect of the subject and all parts of the world

The aim was to get to know and help each other, and the programme was arranged around five main topics · "History of the Oceans", "Populations of the Sea", "The Deep Sea", "Boundaries of the Sea", and "Cycles of Organic and Inorganic Substances in the Sea". Each theme had two morning sessions, with lecturers invited to review contemporary advances rather than the older published work, and in the afternoons the audience divided among four discussions of papers related to the morning topics The main purpose of the conference seemed to be very well achieved a great deal of unpublished work was discussed and new ideas freely exchanged Everyone writing about it will be sure to say how wonderful was the exchange of information between people who knew each other or had read each other's papers The success was largely due to the efforts of the organizing committee, which persuaded oceanographic laboratories all over the world to send the younger members of their staffs as well as directors, and to the generous financial help of some twenty-two government and private organizations in the United States, which overcame much of the difficulty of travel expenses

The "History of the Oceans" section dealt with the shape and structure of the ocean basins, the forces involved, the history of sea water, and the origin of life We begin to know enough about the topography of the Atlantic and Pacific Oceans to form a reasonable overall picture and to know where to study the processes at work Earthquake activity, vulcanicity, gravity and magnetic anomalies are beginning to be related to topography The abyssal plains are as interesting as the ridges We still do not know whether continental slopes are rubbish tips or weathered rock We were warned against too ready acceptance of generalizations attributing all acid rocks found in dredges to transport by ice There should be more active studies to see if they could be locally derived, and to see if they can be dated , we were told to be careful about giving them to museums Another caution, from the biologists, was that while those dealing with living material are very careful about drawing conclusions beyond simple description or regional relationships, palæographers showed less hesitation in making positive deductions about ancient seas The physicists agreed that the difficulty of finding hypotheses to explain the present circulation of the oceans made it quite fantastic to put forward conclusions about those of earlier climatic periods There are, nevertheless, very exciting attempts to obtain evidence from the stratigraphy, chemistry, physics, biology and nuclear relationships of the sediments The same types of evidence, and increasingly penetrating studies of the chemistry of sea water and of its exchanges with the sediments, are also beginning to provide a better framework for judging ideas on the origin of life in the sea

In "Populations of the Oceans", most of the papers and discussions were on biogeography, distribution and behaviour in relation to physiology and environment, evolution and adaptation, and palæobiogeography One of the morning lectures was a fascinating unpublished study of the distribution of bottom-living organisms in relation to the time they spent in the pelagic larval stage It was shown that this time varied with temperature, and that metamorphosis could be postponed by unfavourable conditions There were a relatively large number of papers from the Soviet Union, dealing mainly with the fish, plankton and bottom-living organisms of the Pacific and Antarctic Oceans. Once or twice there was a hint that some of the more special approaches were defending their territories ethology tried to disclaim a paper which showed how a squid kept itself afloat

"The Deep Sea" discussions included the physics and chemistry of circulation, stirring and mixing, the nature and origin of bathypelagic life, the special characteristics of abyssal organisms and the distribution of pelagic-sediment types and nuclear processes in pelagic sediments During discussion of a Soviet study of turbulent diffusion which confirmed some previous work by the late L F Richardson, it was very pleasant to see the charm with which Dr Henry Stommel, probably the only one there who had talked with Richardson, greeted what might be the only mention of his name in the United Nations headquarters with timely reference to his mathematical treatment of foreign politics, arms and insecurity

There was plenty of evidence that new ideas on turbulent processes are being profitably applied to the study of vertical and horizontal movements and to better understanding of internal waves One of the most striking diagrams showed the unexpected complexity of the north and south movements below the Gulf Stream Even more remarkable was one which contoured velocity in a north-to-south vertical section across the sub-surface 'Cromwell' current below the equator in the Pacific Ocean It showed a thin ribbon of water some 100 metres thick and 100 miles wide flowing eastwards at about 2½ knots, mainly between depths of 50 and 200 metres, symmetrical about the equator and known to occur over most of the width of the Pacific Ocean, while all the adjoining water, above, below, north and south, flows in the opposite direction Interpretation of previous climates from the study of the stratigraphy of the deep-sea sediments seems to be one of the most popular oceanic studies, and there was a strong plea for samples of older sediments from depths well below the level attainable by coring Quite shallow bore-holes would give information as valuable as the much discussed deep bore It might be easier to plot previous positions of the equator from the carbonate content of the sediments than to plot previous positions of the poles from evidence of previous magnetism Most of the geologists seem to feel that there ought to be a much greater depth of sediments in the ocean

Discussions on "Boundaries of the Sea" dealt with the effects of land masses and types of coast and sea bottom on the plant and animal populations The rather special conditions in bays and estuaries were emphasized The physical papers dealt with the near-shore circulation One of the most striking papers gave a preliminary survey of the very complex thermal structure in the Straits of Gibraltar obtained with the new towed chain of thermistors Prof W H Munk's morning lecture on the spectrum of sea-level, from ordinary waves to changes in mean sea-level, was one of the most appreciated by the Congress, and the relevant afternoon discussion dealt with a wide range of contributions about effects of pressure, wind, climate and seismic disturbances Further afternoons were devoted to the interchange of energy between sea and air, and to proposed methods for predicting surface conditions and changes in currents There was a very interesting account of observations relating surface slicks to internal waves in a shallow thermocline The internal waves travelled in the same direction as the surface waves and the slicks also moved slowly in the same direction

The section on "Cycles of Organic and Inorganic Substances" included discussions of the chemistry of sea water, the occurrence of biologically active substances, including vitamins and trace elements, primary production, nutrient relationships, balance between living and dead organic matter, exchanges between the sea and sediments and between the sea and atmosphere C E Lucas and J H Steele of Aberdeen and L H N Cooper of Plymouth gave morning lectures There was enough in this section alone to make a conference

One of the most striking features of the Congress was its evidence of the expanding interest of geologists in the ocean Biology, for the first time at such a meeting, probably took second place, and except for the new Soviet expeditions it tended to be concentrated in waters not far from shore The physics of the sea had a good deal to show for the first time, and, not least significant, it could at last be seen to be making observations to check theories

The morning lectures will be published, and everyone attending the Conference had preprints of abstracts of all the papers contributed to the discussions, a very formidable volume of 1,027 pages The simultaneous translations provided by the United Nations staff in English, French and Russian were magnificent We were able to carry on active discussions with Soviet scientists and occasionally listen to them arguing with each other The facilities of the United Nations building for a large assembly with discussion groups are quite extraordinary Most of the 1,200 who registered for the Congress seemed to be staying at the Commodore Hotel only a few blocks away, and there was always someone interesting to talk to The Soviet research ship *Michael Lomonosov*, and five American ships, *Atlantis*, *Chain*, *Crawford*, *Maury* and *Gibbs* were lying at one pier and the French *Calypso* at another There was a good programme of social events including a particularly agreeable visit to the New York Zoological Park

One might penetrate deeper into the science at a smaller meeting, but there could be no better way of getting an impressive though perhaps general idea of the increasing interest and advance in all aspects of the subject For everyone except the organizers it was in fact rather a holiday, and at the same time a most remarkable opportunity for forming new ideas, correcting old ones and thinking what to do next There can be no doubt that some of the work begun there will be continued in growing friendliness by scientists all over the world All marine scientists, and especially those privileged to attend, owe a great debt to Dr Mary Sears and her organizing committee, to all others who helped, and not least to the United Nations

G E R DEACON

DEVELOPMENTS IN THERMODYNAMICS

A SYMPOSIUM on Thermodynamics was held during August 20–25 at Fritzens-Wattens, near Innsbruck, Austria, under the joint sponsorship of the Deutsche Bunsen Gesellschaft fur Physikalische Chemie, and the International Union of Pure and Applied Chemistry, the latter through its Commission on Thermodynamics, the Sub-Commission on Experimental Thermochemistry and the Sub-Commission on Experimental Thermodynamics The symposium was under the general direction of Prof K Schafer (president of the Deutsche Bunsen Gesellschaft fur Physikalische Chemie, and secretary of the Commission on Thermodynamics) with the local arrangements being handled by Prof E Cremer, of the University of Innsbruck Fifty papers were read, and there were 135 participants, representing seventeen countries, including thirty from North America and twenty from Great Britain

Experimental Thermochemistry

The first part of the symposium, under the general heading "Experimental Thermochemistry", contained twenty-three papers Eight of these were studies in bomb-combustion calorimetry The most novel paper of this group, presented by W N Hubbard (Argonne National Laboratory) gave a preliminary account of the successful development of a bomb-calorimeter for combustions in an atmosphere of fluorine gas The bomb is made of nickel, which is rendered inert to attack during the combustion process by a careful pre-fluorination treatment, so that the inner surfaces become coated with a stable nickel fluoride film. Combustion experiments of an exploratory character have been made on twenty-five metals and fifteen inorganic compounds, and three-quarters of these immediately appeared to be suitable for accurate calorimetric study.

Two papers described recent studies using the rotating-bomb calorimeter: in this, the bomb is charged before combustion with a suitable solvent, and rotated after combustion to produce a uniform solution of the combustion products in a definite thermodynamic state. The method has been developed over recent years, and has enabled highly accurate combustion data to be obtained for a variety of organic sulphur-containing compounds. D. W. Scott (Bureau of Mines, Bartlesville) described the further application of the technique to organic fluorides and to some organometallic compounds: results obtained on fifteen organic fluorides were presented, and values reported for the heats of formation of lead tetramethyl, lead tetraethyl, and dimanganese decacarbonyl. The application of the method to organic bromides was described by L. Bjellerup (Lund), and the derived heats of formation critically compared with those independently available from heats of bromination. Comparison of the heats of formation from combustion with those from reaction heats measured by Lacher and his associates at Colorado is satisfactory.

The advantages of polythene ampoules over glass ampoules as containers for liquids in combustion calorimeters were discussed by H. Mackle (Belfast); in the discussion, it transpired that several investigators have experimented with plastic ampoules with considerable success, and that polythene and polyesters are suitable materials to use. Three papers reported new combustion studies by conventional 'static-bomb' procedures. J. D. Cox (National Chemical Laboratory, Teddington) presented results on phenol and the three cresols; M. Colomina (Madrid) gave the results of an investigation of five alkylphenylketones and of the three toluic acids; and J. Tjebbes (Lund) reported on the heats of combustion of butanal and five related compounds. In these studies, the error limits were of the order 0·01–0·02 per cent, which is fairly representative of the degree of precision attainable by modern combustion calorimetric techniques in favourable cases. C. T. Mortimer (Keele) reported heat of combustion data on triphenylphosphine, triphenylphosphine oxide, and triethyl phosphate. These compounds can scarcely be described as 'favourable cases' for combustion study, in view of the difficulty of analysing the products of combustion, so that the error limits of only 0·1 per cent reported by Mortimer are encouragingly small, and suggest that further thermochemical studies on organophosphorus compounds of biochemical importance should be rewarding.

Reaction calorimetry (heats of reactions other than combustion) was represented by three papers. E. J. Prosen (National Bureau of Standards, Washington) gave an account of the extensive studies on the thermochemistry of boron hydrides, including the measurement of the heats of thermal decomposition of the boron hydrides into elements, of their heats of hydrolysis, and heats of chlorination. The heat of formation of boron trichloride from elements has also been measured. Reliable values are now available for the heats of formation of the boron hydrides and of boric acid. Values were derived for the bond-energy terms of various boron bonds, including the tricentric 'bridge bonds' involving boron atoms. The empirical scheme proposed by Prosen was applied to interpret structural features of the more complex hydrides of boron. H. A. Skinner (Manchester) described some thermochemical studies on reactions of diborane, in this case the addition reactions of diborane with olefines to form boron tri-alkyls. These reactions occur rapidly in diglyme solvent at room temperature, and provide a promising route to the heats of formation of the boron tri-alkyls. N. N. Greenwood (Nottingham) described the application of solution calorimetry to the measurement of heats of formation of 1:1 and 1:2 donor–acceptor complexes of gallium trichloride, gallium tribromide, boron trichloride and boron tribromide with various oxygen and nitrogen donors. For a given ligand, the heats of formation of the tribromide complexes are consistently greater than for the corresponding trichlorides, and the heats of reaction of boron trichloride with nitrogen donors are larger than those of gallium trichloride with the same ligands.

Two papers dealt with the thermochemistry of alloys. O. Kubaschewski (National Physical Laboratory, Teddington) reviewed calorimeters suitable for measuring the heat of formation of alloys, with particular reference to calorimeters developed at the National Physical Laboratory for direct measurements on solid alloys formed by heating powdered metal mixtures at high temperatures. A. Schneider (Gottingen) reported directly measured heats of formation of InSb, $MgZn_2$, MgZn and Mg_2Zn_{11}, and indirectly determined free energies of formation of Fe_2Zr, Al_2Zr, Al_3Zr_2 and Al_3Zr_4.

There were three contributions concerned with the heats of mixing of liquids. In one of these, M. L. McGlashan (Reading) emphasized that measurements on heats of mixing should be carried out under conditions in which the vapour phase is entirely eliminated, and described an ingenious calorimeter for this purpose. Heats of mixing of pairs of compounds from the series $Si(CH_3)_{4-n}Cl_n$, and from the series $C(CH_3)_{4-n}Cl_n$ were reported, and discussed in terms of the 'quasi-chemical approximation'. Mixing heats in the binary and ternary systems formed from acetic acid, pyridine and a normal paraffin hydrocarbon (hexane, heptane, etc.) were reported by W. Woycicki (Warsaw). W. Wagner (Dresden) described a series of measurements of activity coefficients, heats of mixing and volumes of mixing of the chlorotoluenes in benzene solvent.

Studies of chemical equilibria were the subject of two papers: in one of these, S. Sunner (Lund) described the use of the gas-phase chromatographic technique to analyse the disproportion reaction MeSSMe + EtSSEt $\rightleftharpoons$ 2MeSSEt, at 25° C and 60° C. A. Pacault (Bordeaux) spoke of a series of equilibrium studies on double decomposition reactions in the solid state between barium sulphate and sodium carbonate and potassium carbonate.

The thermochemistry of tellurium carbonate, tellurium thiocarbonate and barium thiocarbonate, determined from dissociation pressures measured over a temperature range, was described by G. Gattow (Gottingen), and the formation and thermodynamic stability of mixed halides, for example, CuClBr, by R. Perret (Dijon).

I. Wadso (Lund) described a novel adiabatic calorimeter for the direct measurement of heats of vaporization at 25° C. suitable for liquids having a vapour pressure of 5–100 mm. mercury at room temperature. The accuracy achieved was of the order of 0.5 per cent.

The accepted value for the heat of dissociation of nitrogen was questioned by G. Glockler (Durham, N.C.), and L. H. Long (Exeter) raised the interesting problem of the relation between bond dissociation energies and valence-state excitation energies, by specific reference to experimental data available on metal–carbon bonds.

This first part of the symposium was summed up by F. D. Rossini (Pittsburgh) and by J. Coops (Amsterdam). Prof. Rossini, reflecting on thirty years of thermochemistry, recalled the stages in its development. First, to design calorimeters of sufficient accuracy; then to prepare compounds of sufficient purity, and now to extend the range of investigation to substances more difficult to prepare, to purify, and to analyse, requiring full use of all the tools of modern analysis.

Physical Constants

The second part of the symposium, arranged by the Commission on Thermodynamics, contained six papers. The first of these, given by F. D. Rossini (Carnegie Institute, Pittsburgh), concerned the present state of knowledge on the fundamental constants of physical chemistry. Five of these have to be determined by experiment; the others are defined by international agreement. In addition, there are auxiliary constants which derive from the fundamental constants. Since 1951, the ice-point of water has become a defined constant, and improved values have become available for the constants, h, c, e, F and N. In 1960, it is proposed to adopt a new scale of atomic weights based on carbon-12 = 12.0000, which will differ from the present chemical scale by 42 p.p.m., and from the present physical scale by 317 p.p.m.

There were three papers on the thermodynamic scale of temperature, and its realization through the international scale, given by Van Dijk (Leyden), H. Moser (Braunschweig) and C. Tingwaldt (Berlin).

In the range 0–90° K., new measurements have been made on the boiling-points of helium and oxygen, with results which differ by only 1/1,000° and 1/100°, respectively, from the older values of 1937 and 1927. The points 4.215° K. and 90.18° K. (relative to the ice-point = 273.15° K.) representing the boiling-point of helium and oxygen may be regarded as in practically complete agreement with the thermodynamic scale. For n-H_2, the most recent measurements of the boiling-point by various investigations gives the mean value 20.379° K. Secondary fixed points in this region are shown in Table 1.

In the range between the two fixed points of the boiling-point of oxygen (– 182.97° C.) and the boiling-point of sulphur (440.60° C.), which is spanned in the international scale by measurement using the platinum resistance thermometer and the three-term formula, the deviations $\Delta T (= T$ (thermodyn.) $- T$ (internat.)) vary from +0.04° at –80° C. to + 0.13° at 400° C. In the range from the boiling-point of sulphur to the melting-point of gold, in which the international scale relies on the interpolation formula for the e.m.f. of a platinum/platinum–rhodium element, the deviations ΔT reach as high as 1.7° C. It is suggested on the basis of new measurements that the melting-point of gold is 1,064.76° C. in place of 1,063°, as accepted by the international scale. This is a large change to make, and until more evidence is available it is premature to make the change in the international scale.

Table 1. Secondary Fixed Points

Gas	Boiling-point (° K.)	Triple-point (° K.)	λ-point (° K.)
Argon	83.81		
Nitrogen	77.35		
Oxygen		54.34	
p-Hydrogen	20.27	13.81	
n-Hydrogen		13.95	
Helium			2.172

A change in the radiation constant from 1.438 to 1.4388, coupled with an increase of 1.76° C. in the defined melting-point of gold, would eliminate the differences between the international and thermodynamic scales above 1,500° K.

The measurement of temperatures above the gold point by optical pyrometry was discussed by C. Tingwaldt, with particular reference to experimental methods of obtaining ideal black-body radiation from a glowing solid. The lateral radiation from a glowing metal is extensively polarized 'non-black' radiation: by allowing radiation from one source to fall at an angle of 45° on to a glowing metal strip, the combined radiation (reflected and emitted) from the strip is unpolarized, black radiation corresponding to the temperature of the glowing source.

There were two papers describing new designs of calorimeter. One of these, by A. R. Meetham (National Physical Laboratory, Teddington) reported on the design and use of an aneroid bomb-calorimeter made of silver, and vacuum-jacketed, for measuring heats of combustion. The heat transfer coefficient of the calorimeter is very much smaller than that of stirred-water calorimeters. The internal volume is 97 ml., and 0.2 gm. benzoic acid on combustion gave a 3.5 deg. C. temperature rise. The standard deviation of individual estimates of the heat of combustion of benzoic acid was less than 1 part in 5,000.

F. E. Wittig (Munich) described the constructional details and operation of a high-temperature calorimeter for thermal studies on metallic alloys.

Phase Changes in Condensed Systems

The third part of the meeting had as its subject "The Thermodynamics of Phase Changes in Condensed Systems", and was sponsored by the Sub-Commission of Experimental Thermodynamics. Introducing the first session, Prof. D. M. Newitt (Imperial College of Science and Technology, London) said that the object of this meeting, and of its predecessor in London in 1957, was to encourage work to fill the gaps in our knowledge of thermodynamic properties, and especially of those of pure substances.

The majority of the speakers discussed the phase transitions of solids. There were two introductory reviews. The first was by J. E. Mayer (Chicago), who gave a lucid account of the thermodynamics of phase changes in terms of the singularities of the Helmholtz free-energy and emphasized how restricted were the types of transition that could be adequately treated by the present developments of statistical mechanics. The second was by J. P. McCullough (Bureau of Mines, Bartlesville), who outlined an empirical division into seven types of the solid–solid transitions of hydrocarbons and of related substances

A. R. Ubbelohde and his colleagues, Miss E. Rhodes and E. R. Buckle (Imperial College of Science and Technology, London), contributed a group of three papers which discussed the mechanism of melting and freezing. They demonstrated most convincingly that the classical thermodynamic picture of melting as the sharp intersection of two unrelated free-energy curves was inadequate for material composed of complex molecules or ions.

The largest group of papers in this section were detailed studies of particular solid systems. Silver oxide was shown by K. S. Pitzer (Berkeley) to have two anomalous regions in its heat-capacity curve. The first, in the region of 20–40°K., was still without a verified explanation, but the second, 370–470°K., was an annealing of surface and crystal defects. J. G. Aston (Pennsylvania State University) and E. F. Westrum (Michigan) both presented measurements of the heat capacities of systems containing highly symmetrical organic molecules, the *molécules globulaires* of Timmermans. Such systems are of particular interest since the symmetry and 'smoothness' of the molecules allow them to melt with respect to their orientations without disrupting the crystal. This orientation energy and entropy are acquired at one or more transitions below the true melting point. J. E. Spice (Liverpool) reported a detailed study of mixtures of ethylene dichloride and dibromide. The former has long been known to have a broad maximum in its heat-capacity curve at 180° K. On dilution with dibromide the peak moves at first to lower temperatures and becomes less pronounced. The behaviour of the system is, however, complicated by the partial immiscibility of the two solids.

The thermodynamic studies of indane and indene by D. R. Stull (Dow Chemical Co., Michigan) were most notable for the high degree of 'automation' in his calorimeter. This led to many questions regarding the time taken to reach equilibrium in many solid systems.

The magnetic transitions of the divalent salts of manganese, iron, cobalt and nickel were reviewed by J. W. Stout (Chicago). These systems provided unusually elegant examples of the entropy ($R \ln n$) associated with n available electronic states per ion. W. E. Wallace (Pittsburgh) has made a very detailed study by calorimetry and by electrical, magnetic and X-ray examination of the differences between the α and β phases of tantalum hydride and tantalum deuteride. The results were interpreted in terms of differing amounts of short-range and long-range order in the allocation of the hydrogen atoms to the interstitial sites. G. M. Schwab (Munich) reported a study of the α to β phase change in cobalt.

The last group of papers were those that dealt primarily with liquid phases, or in which the interest was in the application of theories of mixtures to the results. R. Heastie (Queen Mary College, London) had studied the phase equilibria of mixtures of krypton with argon and with xenon. The systems were miscible in both solid and liquid phases at the melting-point and the form of the melting curves provided a test for the lattice theories of solution of Prigogine. Unfortunately, true equilibrium in the solid phases was not always achieved. T. M. Storvick and J. M. Smith (North-Western University, Illinois) have studied the thermodynamic properties of mixtures of hydrocarbons and alcohols in liquid and gaseous phases at temperatures up to the gas–liquid critical points. The deviation of their results from those of purely hydrocarbon mixtures was interpreted in terms of the degree and heat of polymerization of the alcohol molecules. J. S. Rowlinson (Manchester) demonstrated that lower critical solution points are not confined to polar mixtures but are commonly found also in binary hydrocarbon mixtures if the size ratio of the constituent molecules is sufficiently large. This behaviour appears to be the rule for high-polymer solutions, almost all of which separate into two phases above the normal boiling-point of the solvent. Finally, R. I. Munn (Vienna) reported a careful re-examination of the phase-boundary curve near the lower critical solution point of the system water + triethylamine. The curve has an unusual, and unexplained, point of inflexion.

Three papers less easy to classify were given by K. S. Pitzer on "Irreversible Thermodynamics", D. White (Columbus, Ohio) on "*o-p* and Isotope Separations by Preferential Adsorption at Low Temperatures", and by G. Watelle-Marion (Dijon) on a spectrophotometric study of the ionization of a divalent–metal salt.

H. A. SKINNER
K. SCHAFER
J. S. ROWLINSON

OBITUARY

Prof. F. Kögl

PROF. F. KÖGL died on June 6 at Utrecht after an illness of about two years. From 1930 until his death at the early age of sixty-one, he had been professor of organic chemistry and of biochemistry at the State University of Utrecht.

Fritz Kögl was born on September 19, 1897, at Munich. He studied chemistry under such famous teachers as H. Wieland, H. Fischer and A. Windaus and became well known himself at an early age by his studies of natural pigments produced by certain bacteria and fungi. While a *Privatdozent* at Göttingen, he was called to a professorship at Utrecht in 1930 as the successor of Van Romburgh and of Ruzicka. Here he widened his field of activities enormously. Interest in growth phenomena of plants led to the isolation and characterization of the auxins. He and his co-workers were the first to recognize β-indolylacetic acid as a natural plant-growth hormone. The consequences of this work are well known to all dealing with the theoretical and practical aspects of plant growth. His studies of growth factors for micro-organisms led to the isolation and the partial characterization of biotin.

From normal growth processes Kögl turned his attention around 1939 to the abnormal growth occurring in animal tumours. He developed a daring hypothesis based on a presumed loss of stereospecificity, resulting in the incorporation of D-amino-acids in tumour proteins. Although this theory could not be maintained against experimental evidence, it proved very stimulating for the continued biochemical approach to protein chemistry. During the past ten years many new fields of current biochemical interest were tackled Among these, important studies on diabetes, on membrane chemistry and on thermo-regulation in the warm-blooded animal must be mentioned

It was a great satisfaction to Kogl himself that a problem started before 1930 was solved just before his final illness This was the elucidation of the chemical structure of muscarin, the poisonous constituent of the fly-agaric (*Amanita muscaria* L) The structure of muscarin had puzzled chemists for more than a century, Kogl and his associates concluded this chapter brilliantly by synthesizing the active compound

Kogl was an inspired investigator and teacher More than sixty doctoral theses are a lasting testimony of the School he founded His death is a grievous loss to the University he served for almost thirty years He is survived by his wife and two daughters

G J M VAN DER KERK

NEWS and VIEWS

Royal Society Officers for 1960

AT the anniversary meeting of the Royal Society, Sir Cyril Hinshelwood, Dr Lee's professor of chemistry in the University of Oxford, was re-elected president The other officers re-elected for the ensuing year were Treasurer, Sir William Penney, member for scientific research, United Kingdom Atomic Energy Authority, Biological Secretary, Sir Lindor Brown, Jodrell professor of physiology at University College, London, Physical Secretary, Sir William Hodge, Lowndean professor of astronomy and geometry in the University of Cambridge, and Foreign Secretary, Dr H G Thornton, lately head of the Department of Soil Microbiology at Rothamsted Experimental Station Other members of Council elected were Prof J F Baker, professor of mechanical sciences, University of Cambridge, Dr J C Burkill, University lecturer in mathematics, Cambridge, Prof D G Catcheside, professor of microbiology, University of Birmingham, Prof T M Harris, professor of botany, University of Reading, Prof L Hawkes, emeritus professor of geology, Bedford College, University of London, Prof A L Hodgkin, Royal Society research professor, Sir Patrick Linstead, rector of the Imperial College of Science and Technology, London, Dr R A Lyttleton, reader in theoretical astronomy, University of Cambridge, Prof H S W Massey, Quain professor of physics at University College, University of London, Prof R A Morton, Johnston professor of biochemistry, University of Liverpool, Sir Alfred Pugsley, professor of civil engineering, University of Bristol, Prof R J Pumphrey, Derby professor of zoology, University of Liverpool, Prof H W B Skinner, Lyon Jones professor of physics, University of Liverpool, Prof W Smith, professor of bacteriology at University College Hospital Medical School, University of London, Dr H W Thompson, university reader in infra-red spectroscopy, Oxford, and Prof J Z Young, professor of anatomy at University College, University of London

National Chemical Laboratory

Dr D D Pratt, C B E

AFTER thirty-four years as a member of the staff of the National Chemical Laboratory, Dr D D Pratt retired from the post of director of the Laboratory on September 30, but in order to assist the new director, Dr J S Anderson, he agreed to occupy the vacant post of assistant director for a period of two months Born at Anstruther, Fifeshire, Dr Pratt graduated at St Andrews and received his post-graduate training both there and at Manchester under Prof (now Sir) Robert Robinson This period was interrupted by the First World War, throughout which he served as an officer in the Highland Light Infantry In November 1925, a few weeks after its opening, Dr Pratt joined the Chemical Research Laboratory, being appointed to take charge of research on tars, particularly those from the low-temperature carbonization of coal, this work had several successful applications in industry His ability was soon recognized by Dr G T Morgan, who quickly promoted him until he was the senior officer under the director When Morgan retired in 1938, Pratt was made officer-in-charge of the Laboratory for the six months which elapsed before Dr G S Whitby became director This was the first of several occasions when he was in charge under various titles, until finally he was appointed director in March 1951 His period in this office has been marked by considerable activity and expansion The rapid increase in radiochemical work led to the creation of a separate laboratory for this purpose The Microbiology Group was re-housed in a new building while responsibility was also assumed for the National Collection of Industrial Bacteria Under Dr Pratt's leadership the Laboratory has grown in numbers, in size and in reputation Its name has been changed to the National Chemical Laboratory, there has been some re-organization of the programme, but in spite of growth and change, Dr Pratt succeeded in maintaining the friendly atmosphere which has always characterized the Laboratory A friendly man himself, his numerous friends will join in wishing him many happy years of retirement

Prof J S Anderson, F R S

PROF JOHN STUART ANDERSON, professor of inorganic and physical chemistry in the University of Melbourne, has been appointed director of the National Chemical Laboratory of the Department of Scientific and Industrial Research at Teddington, in succession to Dr D D Pratt Prof Anderson, whose work in Great Britain and in Australia has placed him among the leading workers in the field of inorganic chemistry, is particularly well known for his contributions in the fields of solid-state chemistry and the chemistry of complex salts He was elected a Fellow of the Royal Society in 1953 Prof Anderson was born in London in 1908 He graduated with first-class honours in chemistry at the Imperial College of Science and Technology, London, in 1928 After three years postgraduate research under Prof H B Baker, he went to Heidelberg for one year In 1932 he joined the staff of the Chemistry Department at the Imperial College Six years later Dr Anderson was appointed senior lecturer in chemistry in the University of Melbourne.

During the War he took part in chemical work aimed at developing new natural resources in Australia He returned to Britain in 1947 to join the Chemistry Division at the Atomic Energy Research Establishment, Harwell, but went back again to Australia in 1954 Prof Anderson is joint author with Prof H J Emeléus of "Modern Aspects of Inorganic Chemistry"

Directorship of Colaba and Alibag Observatories

Mr S L. Malurkar

MR S L MALURKAR, who has retired from the directorship of the Colaba and Alibag Observatories, was born in Hassan on August 15, 1903, and educated in government schools and colleges at Bangalore Due to Prof M Venkatrama Iyer's influence, he turned to original studies in mathematics after 1920, in addition to the subjects in physical sciences taken in the Central College at Bangalore His studies included ellipsoidal wave functions, producing many new results These led to a study of non-linear integral equations for a large number of types of functions, and their evaluation in terms of elliptic functions, asymptotically and otherwise At Cambridge (1927–29), while working in the Solar Physics Observatory, he published a classification of arc spectra of antimony and arsenic His stay at Cambridge was initially helped by the Government of Mysore at the instance of Dr E P Metcalfe and the late Sir Mirza M Ismail He joined the India Meteorological Department in 1930, taking over the investigations on radiation, by this means he examined temperature distributions near heated surfaces, in collaboration with Dr L A Ramdas While at Agra (1936–37) he developed a basic theory of balloons for meteorological purposes In 1948 he was put in charge of the Colaba and Alibag Observatories, where he carried out much important work on geomagnetism and cognate phenomena, the magnetogram and the photolysis of atmospheric ozone in the presence of water vapour He was president of the Physics Section of the Indian Science Congress held at Madras in 1958

Royal Society of South Australia Award .

Dr C G. Stephens

THE Verco Medal is the highest award which the Royal Society of South Australia can bestow on scientific workers who have made exceptional contributions in their particular field of interests This year the Medal has been awarded to Dr C G Stephens for his excellent and outstanding work on soils Dr Stephens attended the Launceston High School, following which he attended the University of Tasmania, where in 1929 he graduated, and later gained his master's degree He was awarded a D Sc by the University of Adelaide in 1950 for his work on Australian soils He joined the Commonwealth Scientific and Industrial Research Organization—then known as C S I R —on a postgraduate scholarship in April 1929 and has remained with the Organization since that date. His association with its Tasmanian staff ceased in 1938 when he was transferred to South Australia To-day, he is head of the Soil Survey and Pedology Section, Soils Division, Adelaide The practical applications of Dr Stephens's work have important bearing especially in the relationships of soil to land uses and development, and to soil fertility problems In consequence, he has been asked to give assistance in these matters both within Australia and overseas Dr Stephens was appointed consultant at the Food and Agriculture Organization headquarters in Rome in 1952 During this period he added to his publications with the report, "Soil Survey for Land Development" In 1954 he was appointed president of Commission 5 (Soil Classification) at the International Congress of Soils at Leopoldville, Belgian Congo Dr Stephens is prominent among Fellows of the Royal Society of South Australia and served two periods as vice-president, namely, 1954–55 and 1956–57, and was president during the year 1955–56

Higher Education in East Africa

IN reply to a question in the House of Commons on November 24, the Secretary of State for the Colonies said that work had begun on the new technical institute building in Nairobi with the help of a £65,000 grant from Colonial Development and Welfare Funds The East African Governments had accepted the recommendations of the Working Party on Higher Education in East Africa for a University of East Africa, comprising three inter-territorial university colleges, of which the re-constituted Royal Technical College would be one, and they were now studying the financial and other implications of the recommendations with the view of preparing a phased programme acceptable to all three territories

Petroleum Industry Centenary

THE September issue of *The British Survey*, published by the British Society for International Understanding, is a survey of the petroleum industry from 1859, the year that Edwin Laurentine Drake drilled his historic well at Oil Creek, Titusville, Pennsylvania, U S A , until the present time, the centenary year of the petroleum industry, which to-day is the biggest industry in the world The survey traces the evolution of the industry from its origins, but also stresses the economic aspects as affecting not only peoples of the producing countries but also those who consume rather than produce petroleum and its multitudinous products—now well over a thousand in the domestic field alone, quite apart from the more widely known, major refined products This article is not merely a re-statement of time-worn facts regarding the oil industry and its international ramifications The sections on "Oil Industry as a Citizen", "Cost, Need and Complication", and "Tendencies to State Participation" are refreshingly original and logically sound The survey concludes with a modest forecast of the rate of increase in demand for oil in the next 10–15 years United States, 4–5 per cent per annum , rest of the Free World, 6–7 per cent per annum , Western Europe, 7 per cent per annum So far as can be estimated at present, the crude oil production to the end of 1958 amounted to the staggering figure of nearly 19 million barrels a day

Soviet Scientific Information in the United States

THE National Science Foundation, Office of Science Information Services, has issued a revised edition of a pamphlet, "Providing U S Scientists with Soviet Scientific Information", which presents a concise picture of what is being done to make scientific periodicals, serials and books published in the U S S R readily accessible to scientists in the United States (pp 36 Washington, D C . National Science Foundation, 1959) The magnitude of the problem is displayed in four tables which give a total of 2,026 periodicals and serials and some 55,732 books in 1955. A selected list of bibliographies published in the U.S.S.R. and a list of dealers in Soviet publications in the United States follow, and the arrangements made for translating Russian periodicals, papers, monographs and abstracts are then briefly described. This account is supported by a table listing Russian scientific periodicals available in English and giving the agency, sponsor and subscription. Some details of abstracting services are included, and there is a list of annual publications which contain reviews of Soviet science.

Geodetic Marker at the South Pole

During the 1960 season of the U.S. Antarctic Research Programme the Coast and Geodetic Survey of the U.S. Department of Commerce will erect a marker permanently identifying a geodetic position near the South Pole. The 3-in. bronze disk to be erected inside a building will indicate the exact location of the South Pole Station of the U.S. Antarctic Research Programme at lat. 89° 59′ 43·6″ S. and long. 24·8′ W. At this spot the scientific leader, Major Palle Mogensen, made 52 independent sets of astronomical observations during the antarctic night. Data resulting from these observations were brought back to the United States by Major Mogensen and passed on to the Coast and Geodetic Survey for computation of the exact position of his observing station. Scientists of the Bureau have determined that the South Geographical Pole lies approximately 1,650 ft. south of Major Mogensen's station.

Vegetation on Mars

It has often been suggested that the dark areas of Mars consist partly of vegetation, particularly in view of the seasonal variation of the intensity of the dark regions. Tests for the high near-infra-red reflectivity characteristic of many plants have all given negative results. A few terrestrial plants, such as some lichens, do not show this characteristic, and possibly such plants are present on Mars. W. M. Sinton (*Astrophys. J.*, 126, 231; 1957. *Lowell Obs. Bulletin*, No. 103; 1959) has suggested and twice carried out a new test for the presence of vegetation. All organic molecules possess strong absorption bands at wave-lengths near 3·4μ, the wave-length of the carbon–hydrogen bond resonance; the precise wave-length depends on the individual molecule. These bands have been studied by Sinton as they appear in the spectra of a number of terrestrial plants, including lichens and mosses. In all the plants tested, the carbon–hydrogen resonance bands appeared to some extent. Tests were carried out on Mars at the oppositions of 1956 and 1958. Relatively little light is received from Mars at a wave-length of 3·4μ, so that very sensitive equipment was needed to render the work possible. A lead sulphide cell cooled in liquid nitrogen was chosen as the detector and preceded by a monochromator equipped with a lithium fluoride prism. The 1956 tests were made at Harvard and the 1958 tests at the 200-in. telescope at Mount Palomar. The radiation received from Mars was analysed theoretically into thermal radiation and reflected solar radiation. The latter shows three absorption bands at 3·43μ, 3·56μ and 3·67μ. These appear to be peculiar to the dark regions of Mars. The bands are weak or absent in the bright regions, and are therefore formed neither in the atmosphere nor in the bright regions of Mars. No other new absorptions were found. Although one cannot be certain that no inorganic molecule can explain these absorption bands, the observed spectrum does fit very closely that of organic compounds and plants. The first two bands are easily observed in plants; that at 3·67μ seemed at first to be an enigma. However, it has now been found in the alga *Cladophora* and appears to be produced by carbohydrate molecules in the plant. Sinton's results are the best evidence yet produced for the existence of vegetation on Mars.

A New Fossil Penguin from Australia

A specimen of part of a fossil penguin named *Anthropodytes gilli* sp. nov., found by E. D. Gill in 1950 in western Victoria, Australia, has been described by G. G. Simpson (*Proc. Roy. Soc. Victoria*, 71, 113; 1959). The actual find (now housed in the National Museum of Victoria) consists of the right humerus, nearly complete, but lacking most of the head. *Anthropodytes* does not show any unmistakable signs of special affinity with any previously named genus, but of the fourteen known genera of fossil penguins in which the humerus is known the closest resemblance is to *Archæospheniscus* from New Zealand. Although *Anthropodytes* was not found *in situ*, evidence relating to attached fossils, situation, and the fluorine test presented by E. D. Gill (p. 121, *loc. cit.*) strongly suggest that the specimen came from an adjacent marine Miocene formation.

Molluscan Fauna of the Netherlands

The Netherlands Malacological Society, Amsterdam, has this year celebrated its twenty-fifth anniversary, and to commemorate the event the Society has published a special supplement to its journal (*Basteria*, Vol. 23) devoted to the Netherlands as an environment for molluscan life. The book contains seven chapters, all in English, with summaries in Dutch. The opening section deals with the history of the study of the Dutch recent Mollusca and this is followed by accounts of the general ecology of the marine, brackish-water, fresh-water and terrestrial mollusc fauna in the Netherlands. Two other chapters are concerned with the nudibranch molluscs and with the dead shells which are found washed up on the beaches. The authors who have contributed to this volume are all well-known authorities on their subjects and the result of their efforts makes good reading not only for those specifically interested in the Mollusca but also for all zoologists who are interested in ecology.

The Agricultural Institute of Ireland

The Council of An Foras Talúntais (The Agricultural Institute), as part of its educational activity in the promotion and encouragement of agricultural research, announces the award of junior postgraduate agricultural research scholarships for the academic year 1959–60 to the following candidates, who will undertake postgraduate studies in the University departments listed: Mr. James Coyle (University College, Dublin), at the Department of Chemistry at the University of Leeds; Mr. Julian Hart (University College, Cork), at the Department of Statistics, University College, Cork; Mr. James Kavanagh (University College, Dublin), at the Department of Botany, University College, Dublin; Mr. Ronan F. Lambe (University College, Galway), at the Department of Chemistry, University College, Galway; Mr. John L'Estrange (University College, Dublin), at the

Department of Agricultural Chemistry, School of Agriculture, University College of North Wales , Mr Brian T Little (University College, Dublin), at the Department of Industrial Microbiology, University College, Dublin , Mr Cornelius Long (University College, Dublin), at the Department of Experimental Physics, University College, Dublin , Mr Vivian Timon (University College, Dublin), at the School of Agriculture, Newcastle upon Tyne (University of Durham)

Ciba Fellowships

Several Ciba Fellowships will be awarded for tenure during the academic year 1960–61 at Continental universities or institutions for research in chemistry, physics or some other allied scientific subject They will be awarded to graduates of universities of the British Isles The basic award for Fellows who wish to continue postdoctorate studies will be £800 per annum plus allowances For candidates who have obtained a first degree in science and wish to undergo training in research, the basic award will be £500 per annum plus allowances The total value of each fellowship will be determined by the advisory panel, and will be sufficient to cover the Fellow's living and other expenses (including fees and cost of travel) during the tenure of his fellowship, which will be for one year, renewable for a further one or two years Six Fellowships were awarded last year for tenure in 1959–60, and Ciba Fellows are at present working at Zurich, Gottingen, Louvain, Heidelberg and Copenhagen Applications should be made in duplicate on forms obtainable from the Secretary to the Ciba Fellowship Trust, Ciba (A R L), Ltd , Duxford, Cambridge The closing date for such applications is January 31, 1960

University News

Belfast

The appointment of Dr F J Wallace (Birmingham) to senior lecturer in mechanical engineering is announced, also L J Clein (Maudsley Hospital, London) to be lecturer in mental health

Bristol

The following appointments are announced Dr J W Barton (Bristol), lecturer in organic chemistry , Dr D L Dineley (Birmingham), lecturer in geology , Dr K R Gough (Bristol), research fellow in medicine , Dr S Griew (London), lecturer in psychology , Dr M A Hollingsworth (London), lecturer in mechanical engineering , B S Smith (Manchester), lecturer in civil engineering , D J Storey (Cambridge), lecturer in electrical engineering , Dr C J Waddington (Bristol), lecturer in physics

The Department of Scientific and Industrial Reseach has made grants as follow to the Department of Physics, £16,680 for research under the direction of Prof C F Powell for experiments in cosmic radiation with balloons photon-induced cascades at different altitudes, and time variations in the primary cosmic radiation over Great Britain , £35,084 to the Department of Psychology, for research into the complexity of industrial tasks , to the Department of Geology, £5,000 for investigations of feldspars in the Connemara granite series and preferred orientation in rock-forming minerals , and £3,550 for investigations of the submarine geology of the continental shelf of the Western Approaches of the English Channel by Prof F Whittard , £3,850 to the Department of Physical and Inorganic Chemistry for equipment , and £2,880 to the Department of Zoology for investigations of the physiological basis of behaviour in protozoa The National Coal Board has made a grant of £1,150 to the Department of Physical and Inorganic Chemistry for a study of carbon surfaces and surface complexes by infra-red spectroscopy, and £1,100 for a study of reactivity of carbon surfaces with oxygen A grant not exceeding £1,150 has been made by the Ministry of Supply to the Department of Electrical Engineering for research on noise generation in inductors with ferromagnetic cores (continuation of grant)

London

Dr. P B D de la Mare (New Zealand), reader in chemistry at University College, has been appointed to the University chair of chemistry tenable at Bedford College from October 1, 1960 The title of professor of experimental physics in the University of London has been conferred on Dr F C Champion (Cambridge), in respect of his post at King's College The following readerships are announced Dr D R Arthur (Wales), in zoology, in respect of his post at King's College , Dr J B Hasted (Oxford), in physics, in respect of his post at University College

Announcements

The Physical Society has announced a conference on "Electron–Phonon Interaction in Solids", to be held in the Townsend Lecture Theatre, Clarendon Laboratory, Oxford, during December 17–18 Further information can be obtained from Miss E Miles, Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S W 7

The Royal Institution has announced the one hundred and thirtieth course of six Christmas lectures adapted to a juvenile auditory The lectures, entitled "The Release and Use of Atomic Energy", will be given by Dr T E Allibone on December 29 and 31, 1959, and January 2, 5, 7 and 9, 1960 Further information can be obtained from the Royal Institution, 21 Albemarle Street, London, W 1

The Home Universities Conference, 1959, will be held in the Senate House of the University of London during December 11 and 12 The topics for discussion are "University Co-operation in the Commonwealth", "University Libraries", and "Administrative Problems in Expanding Universities"

The Institution of Mechanical Engineers is arranging an informal discussion on the Computer in Production, to be held on March 21 and 22 The purpose of the meeting is twofold to introduce chartered mechanical engineers and managers to the latest techniques involving the application of computers in production , and to provide a forum for managers engineers and users to present their views to manufacturers of computers Visits to computer centres and to installations where computers are being used on production problems will be arranged Further particulars can be obtained from the Secretary, Institution of Mechanical Engineers, 1 Birdcage Walk, London, S W 1

Errata Prof Daniel I Arnon has pointed out the following mistakes which were overlooked in proof-reading in his article entitled "Conversion of Light into Chemical Energy in Photosynthesis" in *Nature* of July 4, p 10 p 11, col 2, last word in the first paragraph should read "phosphoglycerate . p 11, equation 3, right-hand side, should be "4 Fe^{2+} ', p 17 col 1, equation 7 left-hand side, should be " $2(Chlp)^{+}$ "

INSTITUTE OF PERSONNEL MANAGEMENT

WITH an attendance of some eight hundred members representing central and local government departments, industrial organizations, universities and other educational institutions from Britain and overseas, the annual conference of the Institute of Personnel Management took place at Harrogate during October 9–11 The theme was personnel management and technological change , and the conference was opened by C H Broadhead, a director of the Imperial Tobacco Co , Ltd , who carried out a wide-ranging survey of the growth, development and possible extension of personnel management in British industry In this review, Broadhead emphasized the continuing need for recognizing the employee as an individual in his own right, and for the specialist personnel managers constantly to act so that general management never forgets its personnel function when there is the risk of subordinating the individual to the organization

Then followed five sectional meetings during one of which comparisons were made between the progress of technological education in the United States, the U S S R and Great Britain From his investigations Dr G Tolley, research manager of Allied Iron Founders, Ltd , suggested that there is every indication that the demand for trained engineers in Russia is now being satisfied by numbers currently graduating from full-time courses , it is probable that attention will now be concentrated upon the fulfilment of other objectives, for example, education in special technologies, such as in the chemical process industries In addition, the existing facilities for training technicians and skilled workers, already organized on a vast scale, may be increased and supplemented Although a great deal is known about the content of scientific and technological courses given in Russian educational institutions, little is known about Russian education for management and labour relations, and the key to the development of Russian society may lie here, rather than in the growth of science or technology as such "Already, however, a largely Victorian society is rumbling rapidly on the move, and we would do well to remember that the huge reservoir of highly educated persons now being created in Russia will probably be capable of demanding something more than heavy industry "

At another meeting Miss J Woodward and T Lupton, of the University of Manchester, discussed the contribution of industrial sociology to management education In the development of management theory Miss Woodward indicated that the early period was dominated by pioneers who sought to establish management theory on scientific foundations and to formulate laws which would describe phenomena and explain the relationship between cause and effect in an industrial situation Classical management theory is based on the philosophy of the one best way, and is deterministic in that it assumes that this one best way can be found by suitable study and research In the past twenty years a move away from determinism has taken place It is now generally accepted that similar administrative expedients can, and often do, produce considerable variations in results In the narrower field of the planning and control of manufacturing operations, tools of operational research are being used to isolate the variables linked with these variations In the wider field of administrative behaviour, the move away from determinism has had less satisfactory results There is a tendency to fall back on phraseology and proverbs and to assume that all variations are dependent solely on personality differences The essential step in the establishment of a scientifically valid theory of management is the isolation and understanding of the variables in industrial situations The most important facet of the investigations made by Miss Woodward in south-east Essex was not its challenge to classical management theory but its attempt to isolate one major variable in industrial situations from that of the actual techniques of production and to link this variable with observed variations in results The information collected suggested that the techniques of a particular system of production impose demands on the human beings involved which limit and control their behaviour

Studies of the behaviour of workers by Lupton and his colleagues have led to conclusions similar to those reached by Woodward in her studies of management. The behaviour of workers is influenced by such factors as the productive methods employed, the related administrative structures of the firm, and market factors In the past five years six detailed investigations of the behaviour of workers, using participant observation as the main research technique, have been carried out In only one of these, carried out among male engineering workers, was there behaviour resembling that found in the Bank Wiring Room of the Hawthorne experiments, that is to say, group controls over the level of output and earnings In some workshops evidence was found of individualism and competitive striving as the normal mode of behaviour, while in others there was an absence of a clearly defined code of conduct relating to output and earnings Further research, taking fuller account of other factors, may lead to a situational theory of workers' behaviour which challenges many of the naive sociological and psychological generalizations which pass as 'principles of human relations'

In a discussion on government policy and company pension schemes for manual workers, V R Jackson, head of the Pensions Department, Unilever, Ltd , argued that employers would be unwise to 'contract out' of the graduated part of the State scheme which comes into force in April 1961 Against this, H A R Barnett, a consulting actuary, provided many reasons why employers should seize the opportunity to contract out

The effect of equal pay on employment policies was examined by R E Griffiths, secretary to the Local Authorities' Conditions of Service Advisory Board During the past five years equal pay has been introduced in the public services—including the Civil Service, the Local Government Service (including teachers), the nationalized industries, and the Health Service Progress to man's rate of pay is, by instalments, to be completed in 1961

From observations of the workings of equal pay, Jackson has concluded that, where there is freedom of choice, equal pay will encourage the appointment and promotion of men in preference to women, equal pay may mean less security for women in times of recession, where women form a substantial proportion of an employed group, as in the basic teaching grade, equal pay-rates will tend to be lower than for a solely male group, and scales may be longer This will tend to drive men out of the group, the increase in the inequity of living standards between family men and single women without dependants receiving equal pay will probably necessitate some form of additional family allowances, and, finally, equal pay raises costs, and may force reductions in the numbers employed

The concluding session was concerned with the interaction of operational research and personnel management The organization and mode of working of an operational research department was described by Stafford Beer, head of the Department of Operational Research and Cybernetics, United Steel Companies, Ltd

Operational research involves the application of the methods of science to operations, whether military, industrial economic, or of any other kind It has to consider systems of men and machines, materials and money, it is concerned with the regulation of these systems, with their decision processes, with their operation for maximum profit or minimum wastage or optimum use of resources Operational research deals with the strategy of operations not from general concepts of what management 'ought' to be like, but from the scientific principles of quantification, of inference, of experimental and analytical technique

Beer suggested that operational research was relevant to personnel management for three reasons First, the task of managing operational research itself has been little considered by those responsible for personnel management Most big companies in most industries employ operational research workers These departments have to be organized, and their organization poses very difficult and unusual problems The departments have to be fitted into the existing organization of the parent company or institution on a routine basis, and this also raises difficult issues The growth of this activity has been rapid it has led to an extremely intractable education and training problem in which few educationists have taken an interest Staff are still particularly hard to find, and their suitability hard to assess By informing themselves about the topic of operational research, about its capabilities, its organization and its staff, personnel managers would put themselves in a position to help both their companies and the operational research movement to achieve a properly organized and integrated activity

Secondly, an operational research discussion of its own organization is of possible interest to personnel managers in another way Organization is itself a typical subject of operational research study In discussing the organization appropriate for operational research, points of interest for other kinds of organization may well be uncovered The third point of relevance for personnel managers is the most important Operational research can certainly be applied to personnel problems themselves Personnel management could well commission studies in its own field of problems, when operational research would be found capable of handling systems of exclusively human components. A good demonstration of it in practice was given by L T Wilkins and Herbert Mannheim in their scientific attack on operational problems of the Borstal system This has been hailed as the greatest advance in penology for twenty-five years

The application of operational research to the understanding of human beings was considered by Prof R W Revans, of the Department of Industrial Administration, University of Manchester The human problems of industry are not so much with individuals as with groups There might be profit in trying to understand the nature of authority, the ways it is exercised and the effects that it produces The highly complex relationships perceived as authority, namely, the willingness of one man to do what another man wants him to do, may change their nature simply by being discussed To that extent these problems do not have the objectivity that is often regarded as a necessary attribute of scientific material There is no evidence, for example, to suggest that if one hundred men sit down and talk about the law of gravity for a week, the nature of the law is in any way changed But if one hundred men sit down and talk for a week about a strike in a motor factory, it is likely to make the strike very much worse There is a difference between the study of the social problems of industry and the study of the problems of classical science, but it does not deny the validity of observational methods in the study of society

A particular study of authority arises out of some work that Revans and his colleagues were invited to do at hospitals in the region of Manchester The immediate and urgent problem was—and still is—that there are nothing like enough nurses in our hospitals and there seems little promise of obtaining substantially more

An Indian student spent two years laboriously tracing the records of more than four thousand hospital employees in five comparable hospitals in Lancashire, and in 1958 brought out the first conclusions Srivastava showed that, first, the voluntary wastage of nursing students during their three years of training differed significantly from one hospital to another and that, secondly, the hospitals with high voluntary wastage-rates among students had high wastage-rates among other members of staff, such as cleaners, auxiliary nurses, ward sisters and even the matrons themselves All popular explanations, such as early marriage, the attractions of better paid jobs in the same town, even the decay of modern youth to-day, were shown to be illusory There appears to be about every hospital some factor of cohesion which determines whether anybody in its service will want to stay there or not, and this cohesion (or lack of it) extends up to the matron and down to the most junior nurses

It appeared that this factor of cohesion might have other manifestations If the staff were prepared to stay at one hospital twice as long on average as at another, one might expect this to be reflected in some effect upon the patients Srivastava found that the order in which the hospitals were placed for their ability to retain their student nurses was precisely the same as the order in which they were placed for the 'length of patient stay' Srivastava chose cases which were, between hospitals, most directly comparable For this he chose cases of appendicitis During the year 1958, considerably more than a thousand people were operated upon for this complaint in five hospitals, a perfect fit was found between the percentage of student wastage and the average length of patient stay Average wastage ranged from 38 per cent in the hospital best able to retain its students to 65 per cent in the worst, the mean length of stay for appendicitis ranged from 7 5 days to 11 9 A significant concordance between all staff wastage and all clinical conditions examined was also found Altogether, more than 5,000 cases of appendicitis, hernia, colectomy, partial gastrectomy, cystoscopy, asthma, bronchitis and pneumonia and head injuries have been examined, making allowance for differences between hospitals that have convalescent homes and those that have not, the hospital that can keep its staff longer can also deal with its patients more quickly

This new law reinforces confidence in the organic concept of the hospital, it suggests that staff and patients seem to be influenced to the same extent The source of this influence must be sought in the wards themselves It has already been found that, in the hospitals with the high wastage rates, the student nurses particularly, but other nursing staff as well, complain of a general uncertainty about their work, their instructions often appear to be haphazard and it seems difficult to get decisions out of their committees "A student nurse of 19 may not be afraid of hard work, does not complain about her money or the plainness of her diet, but is terrified of being put into situations which she does not understand because they have not been explained" A feeling of helpless ignorance is more corrosive of morale than the fear of any official rebuke which such ignorance may bring down The girl who becomes a nurse has enough concern for her work to fortify her against the terrors of authority as such But if she feels that she cannot carry her responsibility to her patients because she does not know what to do, she will in the end withdraw from an impossible situation, very often with regret

Revans also drew upon later investigations to examine whether or not the character of the individual hospital is tied up with resistances to the friendly exchange of views and arrival at decisions He suggested that this inquiry into the nature of authority will lead to new fields of inquiry and understanding

ALKALI ION DETERMINATIONS BY MEANS OF GLASS ELECTRODES

THE possibility of measuring alkali ion concentrations in aqueous solutions by means of an electrode potential offers many advantages over other physical methods such as the flame photometer Since the publication in 1957 by Eisenman, Rudin and Casby[1] on the sensitivity to sodium and potassium ions of glass electrodes made from sodium alumino-silicate glasses, interest in the subject has been growing rapidly and a Research Colloquium was held in the Department of Glass Technology, University of Sheffield, on May 6 to discuss the theory of the electrodes and some possible fields of application

Dr G Mattock (Electronic Instruments, Ltd) reminded those present that the development of glasses responsive to alkali metal ions has always been a possibility from the early recognition in studies on *p*H of glasses showing 'alkaline error' In broad terms, the first requirement is to develop a glass which has a large alkali metal ion error There seems to be no fundamental difference between glasses functioning for *p*H and those for alkali metal ions all electrode glasses show some sensitivity both to hydrogen and to alkali metal ions, even, apparently, to other singly charged cations such as ammonium The chief problem in devising compositions is the achievement of selectivity to a given ion in the presence of others

Lengyel and Blum[2], Nikolskii and his co-workers[3], and Eisenman, Rudin and Casby[1] have all shown the importance of aluminium and/or boron in promoting alkali metal response when substituted for silica in a glass The last-named workers have carried out a very exhaustive study on the $Na_2O - Al_2O_3 - SiO_2$ ternary system and have worked out extensive theories to cover the whole field of specific interactions at surfaces[4] The fundamental importance of ion-exchange is accepted, the theory considering the factors affecting electrostatic attraction between ions in solution and the glass surface The relative selectivity of glass response to different cations is qualitatively accounted for in terms of the competing effects of negative fields due to residual charges on oxygen ions (caused by the isomorphic introduction of trivalent aluminium or boron into the tetravalent silicon framework) and the hydrating tendencies of the bare cations At low negative field-strengths on the lattice the ability to dehydrate a cation is weak, so that the order of selectivity (considered to depend on the effective radii of the ions) is related to the order of size of hydrated radii At high field-strengths, this order can be reversed, and with intermediate fields, intermediate orders can be obtained—but significantly only eleven are theoretically predictable and only eleven have been found These orders are

(1) Cs, Rb, K, Na, Li
(2) Rb, Cs, K, Na, Li
(3) Rb, K, Cs, Na, Li
(4) K, Rb, Cs, Na, Li
(5) K, Rb, Na, Cs, Li
(6) K, Rb, Na, Li, Cs
(7) K, Na, Rb, Li, Cs
(8) Na, K, Rb, Li, Cs
(9) Na, K, Li, Rb, Cs
(10) Na, Li, K, Rb, Cs
(11) Li, Na, K, Rb, Cs

Eisenman and Rudin are shortly to publish a full description of their treatment

Dr Matlock had been principally concerned up to now with studying the inductive effects of different polarizing substituents on the selectivity properties of glasses, and with obtaining easily workable glasses, a disadvantage of the original compositions of Eisenman, Rudin and Casby having been their extremely high softening points, making them difficult to fabricate into electrodes Collaboration with Dr Eisenman has now enabled development to be made on the basis of the Eisenman and Rudin theory, giving both ease of workability and improved selectivity Glasses responsive to potassium have also been made There seems to be a wide field of application in chemical analysis, in salinity measurements on waters and soils and in various industrial fields, as well as in biochemical and medical spheres

Dr W Bartley, Mr A Renshaw and Miss B M Notton (Cell Metabolism Research Unit, University of Oxford) described tests carried out on experimental electrodes of aluminosilicate glasses prepared in the Department of Glass Technology, Sheffield Sodium aluminosilicate glasses similar to those recommended by Eisenman for sodium ion measurements were compared with sodium alumino-borosilicate glasses, in which some alumina and/or silica had been replaced by boric oxide in order to improve the technological properties

Electrodes were filled with an acetate buffer (0 15 *M* sodium acetate + 0 1 *M* hydrochloric acid *p*H 4 8) in which dipped a silver – silver chloride electrode The reference electrode was of the Beckmann 'fibre' type, the potentials were read on a 'Vibron' electrometer (Electronic Instruments, Ltd) and recorded on a 'Record' pen recorder The potentials were measured of solutions of sodium, potassium and lithium ions and hydrochloric acid ranging from *M* to 10^{-5} *M* and of mixtures of sodium and potassium ions in the same range All solutions except hydrochloric acid were buffered to *p*H 10 by the addition of *tris*(hydroxymethyl)aminomethane The test solutions were left in contact with the electrode until a stable voltage was recorded and the time taken for this to occur was noted

In Table 1 the rates of change of voltage with concentration are given for each of the four cations with each glass In general, the slopes with sodium ions were similar to those with hydrogen ions, ranging between 50 and 60 mV for each tenfold change of concentration The slopes with potassium and lithium ions were some half to three-quarters of that with sodium and varied considerably with glass composition It can be seen that the introduction of boric oxide has caused no systematic change in the alkali ion sensitivities of the sodium aluminosilicate glasses

Table 2 shows the voltages developed in molar solutions of the ions The values for *M* H^+ and *M* Na^+ are considerably higher than the values for *M* K^+ and *M* Li^+ Again it is difficult to observe a consistent trend on the introduction of boric oxide.

Table 1 RESPONSE OF VARIOUS GLASS ELECTRODES TO CHANGES IN ION CONCENTRATION

Glass	Average slope (mV /*p* unit) with Na^+	K^+	Li^+	H^+
NAS 11–18*	52	34	22	52
NAS 13–20	50	36	40	56
NAS 12½–12½	50	40	50	60
NABS 1/1/1/4†	58	30	50	52
NABS 1/1/½/5	52	34	46	49
NABS 1/½/½/6	55	42	34	57

Table 2 VOLTAGE GIVEN BY VARIOUS GLASS ELECTRODES WITH THE SAME CONCENTRATION OF DIFFERENT IONS

Glass	Voltages (mV) with molar concentration of Na^+	K^+	Li^+	H^+
NAS 11–18*	+ 93	– 102	– 26	+ 138
NAS 13–20	+ 100	– 47	– 8	+ 131
NAS 12½–12½	+ 100	– 36	+ 10	+ 185
NABS 1/1/1/4†	+ 91	– 90	– 16	+ 162
NABS 1/1/½/5	+ 96	– 56	– 18	+ 129
NABS 1/½/½/6	+ 88	– 32	– 48	+ 100

* Molecular per cent of sodium monoxide and alumina respectively

† Molecular ratios of sodium monoxide/alumina/boron trioxide/silica Thus it may be noted that sodium aluminosilicate 12 5/12 5 is equivalent to sodium alumino-borosilicate 1/1/0/6

The behaviour of the electrodes was investigated under the important practical conditions occurring when two alkali ion species were present simultaneously It was anticipated that potassium, for example, would interfere with the sodium response of the electrodes when the voltages produced by the two ions separately were about the same Thus *M* potassium chloride would be expected to interfere with all solutions of sodium chloride below 0 001 *M* In the sodium aluminosilicate series of glasses this was true, but in the sodium alumino-borosilicate series interference of the potassium ion already occurred at 0 1 *M* sodium chloride In general, it was not found possible to predict the response of an electrode to a solution containing two ion species, on the evidence of its response to each separate ion Thus the introduction of boric oxide into the sodium aluminosilicate glasses caused a great deterioration of specificity not revealed by the data of Tables 1 and 2

The time taken for the electrodes to register a stable voltage was also measured It varied with the composition of the glass and also with the composition of the ion mixture , but, in general, it was increased by the introduction of boric oxide Thus, the sodium aluminosilicate glasses reached equilibrium in a matter of a few minutes while the sodium alumino-borosilicate glasses took some hours to reach equilibrium All electrodes responded fastest at *p*Na 1 and most slowly at *p*Na 2 or 3 In the presence of potassium ions the equilibration time was increased but the electrodes still reached equilibration fastest at *p*Na 1 and slowest at *p*Na 2 or 3

Of the glasses tested the most useful and least subject to various interferences were the sodium aluminosilicate series ; of these sodium aluminosilicate 11–18 was the best Measurements were made of the sodium content of standard solutions of various sodium salts with a sodium aluminosilicate 11–18 electrode calibrated against sodium chloride With this system, although the measured and standard solutions usually agreed to within 10 per cent, divergencies of up to 40 per cent could occur However, differences of less than 1 per cent in the sodium content of two solutions of a given salt could be detected easily by the use of the electrodes, although the precise concentrations of either solution could not be measured accurately

It was concluded that the electrodes used could not be relied upon for accurate measurements, but were capable of giving a sensitive indication of changes in ion concentrations

Dr J S Stanley (J A Radley's Industrial Research and Development Laboratories, Reading) described the application of glass electrodes responsive to sodium to the study of micelle formation in solutions of paraffin chain salts and dyestuffs Aggregation is easy to detect from the fall in the activity coefficient of the sodium ion, which occurs above the critical micelle concentration The critical micelle concentrations of sodium laurate, sodium lauryl sulphate and dioctyl sodium sulphosuccinate determined by this method agreed well with previous determinations by other methods, and aggregation in several dyestuff solutions has been detected.

The method is particularly useful for determining the association of the counter ion with the micelle, since the electrode determines sodium ion activities directly Dr Stanley said that, so far as he could

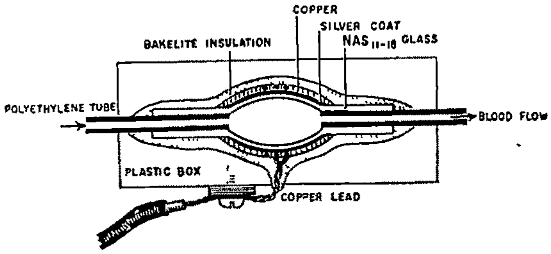

Fig 1 Diagrammatic section through a tubular type of glass-to-silver sodium electrode Measurements are approximately 0 5 cm × 2 0 cm

ascertain, this was the first time that glass electrodes responsive to sodium had been applied to problems outside the biochemical field

Dr J A M Hinke (American Life Insurance Medical Research Fellow, Department of Biophysics, University College, London) discussed the application of glass electrodes responsive to alkali ions in experimental biology and medicine He reviewed the design and performance of a tubular type sodium electrode for measuring plasma sodium of an anæsthetized animal (Fig 1)[5] A thin bulb was blown in the middle of a tube of Eisenman sodium aluminosilicate 11–18 glass and electrical contact was made to the outer surface by a coating of silver Potential changes were amplified with a Cary vibrating reed electrometer and recorded on a Grass model 5 polygraph The electrometer provided enough gain to detect changes of 1 milliequivalents sodium/litre in a total of 140 milliequivalents/litre Such performance indicates two possible advantages of these electrodes over the alternative method of flame photometry for alkali ion determinations, namely, the detection of less than 1 per cent change in sodium concentration and the possibility of continuous recording

Evidence was presented that changes in the flow-rate influence the response of the tubular electrode, but it was shown that this limitation can be minimized by a suitable design of the electrode shape

A second application of glass electrodes has been made on a micro scale (see *Nature*, October 17, p 1257), the glass for which was supplied by Friedman (University of British Columbia) and behaved similarly to Eisenman's sodium aluminosilicate 11–18 and 27–8 glass Table 3 indicates the performance of a microelectrode sensitive to sodium over the physiological molar concentration range of sodium and potassium at *p*H 8 12 Other experiments were cited which indicated that hydrogen ion interfered significantly below *p*H 6 5 but that affects of *p*H could be ignored between *p*H 7 and 8 Over this biological range of sodium, potassium and hydrogen ions, the electrodes behave according to Eisenman's modified empirical formula[6]

$$E = E^0 + \frac{RT}{F} \ln(a_{\text{Na}} + k_{\text{NaK}} a_{\text{K}})$$

where E is measured electromotive force, E^0 is standard potential, a_{Na} and a_{K} are activities of sodium and potassium ions respectively and k_{NaK} is empirical constant for a given glass composition

Table 3 EXPERIMENTAL RESPONSE (MV) OF SODIUM ION SENSITIVE MICROELECTRODES

All solutions buffered to *p*H 8 12 with 0 2 *N* *tris*(hydroxymethyl)-aminomethane and 0 1 *N* hydrochloric acid

	[K⁺] 0 016	[K⁺] 0 04	[K⁺] 0 08	[K⁺] 0 12	[K⁺] 0 16
[Na⁺] 0 016	− 53 5	− 53 5	− 53 5	− 53 5	− 53 5
[Na⁺] 0 04	− 31 0	− 31 0	− 31 0	− 31 0	− 31 0
[Na⁺] 0 08	− 13 5	− 13 0	− 13 0	− 13 5	− 13 5
[Na⁺] 0 12	− 3 5	− 3 5	− 3 5	− 4 0	− 4 0
[Na⁺] 0 16	+ 3 5	+ 3 5	+ 3 5	+ 3 5	+ 3 0

Given standardized sodium and potassium selective electrodes, the potential of each can be measured in an electrolyte system and the equation can be solved for A_{Na} and A_{K} simultaneously This has been done inside muscle cells of crab and lobster using the microelectrodes as already described in *Nature* (*loc cit*)

The discussion which followed emphasized the practical advantages of determining alkali ions by electrodes rather than by flame photometry, these electrodes can give greater sensitivity, they can be used non-destructively with continuous recording and they give a direct determination of activities, instead of total concentration, which may be of great importance in biological or colloidal systems The theory of action of the electrodes was discussed at some length and the need for a fuller investigation of the effects of varying the glass composition was emphasized

J O. ISARD

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POLARIZATION OF LIGHT FROM NOCTILUCENT CLOUDS

By GEORG WITT

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MEASUREMENTS of the polarization of light from noctilucent clouds have recently been made in Sweden A commercial 35-mm stereo-camera body was fitted with a pair of *f*/1 65, 50 mm Petzval projection lenses Rotatable 'Polaroid' filters, geared to remain mutually perpendicular, were mounted in front of the lenses Sliding Wratten gelatine filters were used to select the desired range of wave-lengths The image sizes were 22 mm × 22 mm, 1 mm corresponding to approximately 1° in the field of view

This equipment was set up for operation at Torsta (lat 63 3° N, long 14 6° E) during July and August 1958 The station has been used for noctilucent cloud observations since 1955 (see refs 1 and 2) A brilliant display, in good visibility conditions, occurred on August 10–11, 1958, and a sequence of polarization measurements was carried out as follows

The camera was directed at a bright feature in the cloud system Knowing the position of the Sun, the 'Polaroid' filters were orientated to be parallel and perpendicular to the plane containing the Sun, the cloud, and the observer Two exposures were made in quick succession with two different colour filters, the first centred on 4900 A , the second on 6100 A (effective centres on the emulsion used) Exposures varied from 5 to 60 sec on Kodak Plus-*X* emulsion The procedure was repeated for different cloud features covering as wide a range as possible in solar elongation Neutral step-density filters were photographed on the same emulsion, and developed with the cloud records, to provide calibration for subsequent analysis by photodensitometry Neutral step-density filters were photographed on the same emulsion, and developed with the cloud records, to provide calibration for subsequent analysis by photodensitometry The brightness of the features used was at least four times greater than that of surrounding minima, which must include the twilight foreground light Thus no correction for this component was considered necessary

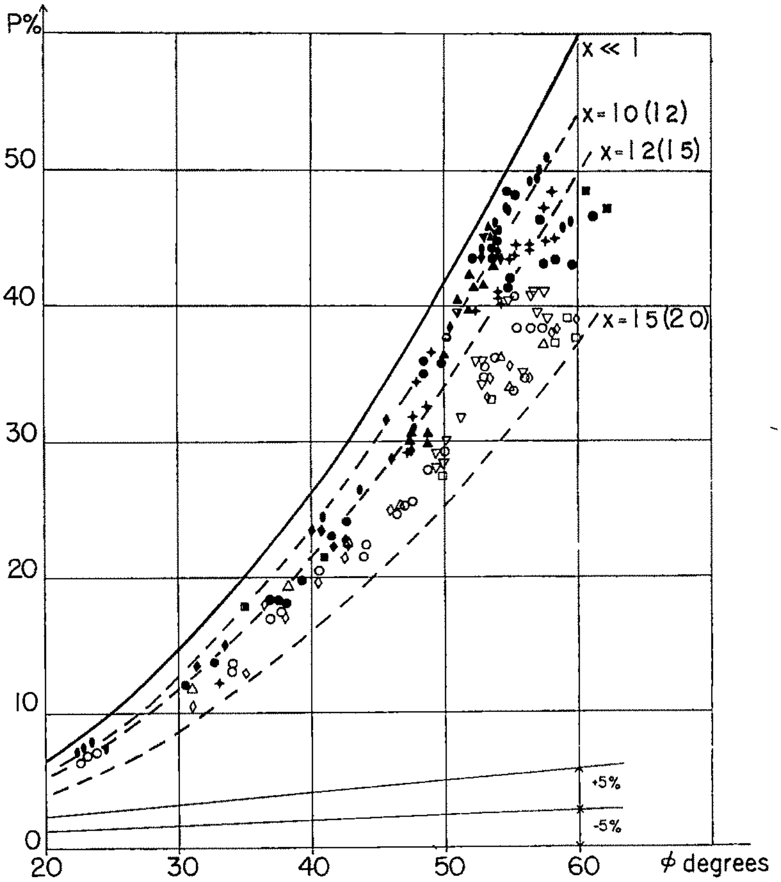

Fig 1 Degree of polarization as a function of scattering angle Open symbols refer to the blue wave-length (λ = 4900 A), and filled symbols to the red (λ = 6100 A) The magnitude of an allowed scatter of 5 per cent is shown by straight lines at the bottom

The interpretation of these results is based upon the Mie theory of scattering of light by small particles (see Van de Hulst[3]) If I_1 and I_2 are the intensities of the components of the scattered light polarized perpendicular and parallel to the plane of incidence and scattering respectively, then the degree of polarization of the scattered light is defined as $P = (I_1 - I_2)/(I_1 + I_2)$ In this application, the cloud is assumed to be illuminated by natural light from the Sun The theory predicts that the polarization and intensity of scattered light are functions of the scattering angle φ, the size parameter $x2 = \pi r/\lambda$, where r is the radius of the particle and λ the optical wave-length, and of nx, where n is the refractive index of the particle At low elevation angles, selective extinction in the atmosphere is serious, but there is no reason for expecting the polarization to be significantly affected This is an important advantage of polarization over spectral observations

In Fig 1 the horizontal scale is the computed scattering angle and the vertical scale is the degree of polarization The limiting case of Rayleigh scattering is shown by the solid curve The broken lines show the predicted polarization for particles with x = 1 0, 1 2 and 1 5, as indicated, if the refractive index n is 1 55 For n = 1 33 (water) the values of x are those given in brackets Measured polarization values are shown by the symbols, which are of different shape for different pairs of exposures Seven blue and eleven red exposures were made on various parts of the cloud over a period of 3 hr Open symbols refer to the blue wave-length, and filled symbols to the red

Points to note are as follows The observed behaviour is of the kind predicted by the theory for a rather limited range of particle sizes, and the same range of sizes accounts for the results on the two separate wave-lengths Systematic errors of analysis could scarcely be invoked to account for this regularity of behaviour Thus a value of the radius r = (1 0 ± 0 1) 10^{-5} cm (n = 1 55) accounts for the results There is evidently not an appreciable proportion of particles of larger than 2 × 10^{-5} cm radius , one cannot say if there are smaller particles present There is no evidence, so far, of any change in the effective radius during the progress of the display, or from place to place in the cloud

Further polarization measurements are being made Stereophotogrammetric results obtained at Torsta on the same cloud have shown that the material of the cloud moved in a south-westerly direction with a velocity of the order of 100 m /s , while a system of bright waves moved more slowly in the reverse direction The effect has been demonstrated in a convincing manner by time-lapse films taken of these and subsequent clouds It is the movement of the bright waves which has commonly been reported in the past[4]

I am indebted to Dr and Mrs F Volz, and Mr N Wilhelm for valuable assistance The astronomical institutions of Stockholm and Uppsala provided the facilities for microdensitometry

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REDUCTIVE PHOTO-BLEACHING OF EOSINE

Primary Processes indicated by the Flash Technique

IT is well known that a de-aerated solution of eosine in ethanol when irradiated undergoes reductive bleaching. Imamura and Koizumi[1] concluded, from the kinetic studies of this reaction, that a semiquinone radical with a life-time not less than 10^{-3} sec. is formed from the triplet state of dye and ethanol.

The primary processes of this photo-bleaching have now been studied by the flash technique, and in addition to semiquinone, another intermediate with a life-time of the order of 10^{-3} sec. was found spectroscopically. A photolysis flash lamp and a spectro-flash of 'half-width' approximately 60 and less than 20 μsec. respectively were used. The results obtained may be summarized as follows.

At 0.6 msec. after the start of the photolysis flash, the main absorption of eosine decreased to 60 per cent of that of the initial solution and a transient increase of absorbance was observed in the region from 350 to 480 mμ. Subtracting from this the absorbance due to the remaining eosine, the quantity of which was evaluated from the depression of the absorbance in the region of wave-lengths longer than 480 mμ, the spectra of the transient species were obtained (see Fig. 1).

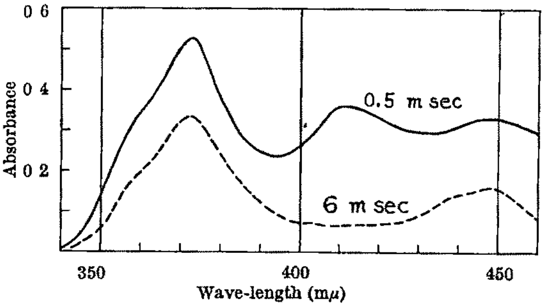

Fig. 1. Absorption spectra of transient species in eosine

Three peaks occur, at 373, 410 and about 450 mμ. After 5 msec., the peaks at 373 and 450 mμ (*A* band) still maintained considerable intensity, whereas 410 mμ (*B* band) declined appreciably. After several minutes, the former band also completely vanished and the eosine spectrum was recovered, corresponding to 88 per cent of that of the original solution. The 12 per cent loss is attributable, without doubt, to permanent bleaching.

In the presence of air, neither transient spectral change nor permanent bleaching was observed. The de-aerated aqueous solution of eosine also showed no such transient spectral change.

These results imply that two transient species are formed in the initial stage of the reductive photo-bleaching of eosine, and that at a certain early stage after flashing, most of the dye molecules are converted into such intermediate species with life-times not less than about 10^{-3} sec.

There is little doubt that the *A* band is due to the semiquinone radical of eosine. As regards the *B* band, it is certain that this is not due to a triplet state, because no similar band is observed in an aqueous solution in which the triplet state is not deactivated so efficiently as in ethanol solution. Hence the *B* band must be attributed to some unknown molecular species which perhaps precedes semiquinone; it would be reasonable to attribute this to a certain kind of molecular complex between excited dye and ethanol.

The primary processes of the photo-bleaching may be pictured as follows:

$$\begin{array}{lllllr} D & + \; h\nu & \rightarrow & D^{*} & & (1) \\ D^{*} & & \rightarrow & D & + \; h\nu' & (2) \\ D^{*} & & \rightarrow & D^{t} & & (3) \\ D^{t} & + \; RH & \rightarrow & X & & (4) \\ X & & \rightarrow & D & + \; RH & (5) \\ X & & \rightarrow & DH^{\cdot} & + \; R & (6) \end{array}$$

where D and RH represent dye and ethanol, and X is the molecular complex suggested above; the other symbols have the usual meaning. This scheme accounts for all the experimental results, including those formerly obtained from kinetic studies. Only two of them will be taken up here. (*a*) The observation that only 12 per cent is permanently bleached in spite of the fact that almost all the dye molecules are converted to intermediates with life-times not less than about 10^{-3} sec. is due to process (5), which plausibly proceeds faster than (6). (*b*) The fact already established that the reductive photo-bleaching is completely inhibited by the presence of a very small quantity of oxygen is interpreted as due to X being deactivated by oxygen by the process $X + O_2 \rightarrow D + RH + O_2$. Imamura and Koizumi's scheme that semiquinone is destroyed by oxygen is not in agreement with the fact that the *B* band is not observed in the aerated ethanol solution.

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MASAO KOIZUMI

Effect of Added Substances on the Rate of Reductive Photo-bleaching

THE alcoholic solution of eosine, when de-aerated and irradiated by visible light, undergoes photo-bleaching which proceeds via the formation of a semiquinone of the dye[1]. The effect of the added substances on the rate of bleaching has now been examined, and it is found that some substances accelerate the rate appreciably and in a very specific manner.

A sample degassed carefully by repeated vacuum distillation was illuminated by light from a tungsten projection lamp, transmitted through a filter cutting off wave-lengths less than 450 mμ.

Since the absorption spectra of the irradiated solution, in all cases, gradually declined, keeping the same shape as that of the original solution, the rate of bleaching was traced simply by measuring the absorption spectra at suitable time intervals with a Hitachi spectrophotometer *EP U-2A*.

The rate of bleaching can always be expressed by the formula:

$$-\frac{dc}{dt} = \frac{k}{d} I_0 \left\{ 1 - \exp(-\alpha c d) \right\} \times 10^3 \qquad (1)$$

where c is the concentration of dye in mole/litre, I_0 is the intensity of illuminating light (mole cm.$^{-2}$ sec.$^{-1}$), α is the effective molar absorption coefficient and d the thickness of the solution in centimetres.

Integration of (1) gives:

$$\ln(\exp \alpha c_0 d - 1) - \ln(\exp \alpha c d - 1) = 10^3 k I_0 \alpha t \qquad (2)$$

By using the properly determined value of α, one can obtain k from the inclination of a linear plot of $\ln(\exp \alpha cd - 1)$ against t

Typical results showing the effect of the added substances are summarized in Table 1 (temperature, 25° C)

Table 1

Retarding Effect

*Iso*pentane		*n*-Hexane	
Mole fraction	Relative k	Mole fraction	Relative k
0 334	0 20	0 309	0 59
0 143	0 43	0 130	0 67
0 0814	0 84	0 073	0 89
0 0529	0 85	0 047	1 01
0	1	0	1

Benzene		*Cyclo*octatetraene	
Mole fraction	Relative k	Mole fraction ($\times 10^5$)	Relative k
0 220	0 61	650	0
0 141	0 63	65	0 26
0 0681	0 69	32 2	0 42
0 0334	0 70	8 07	0 61
0	1	0	1

Accelerating Effect

n-Hexene		*Cyclo*hexene	
Mole fraction	Relative k	Mole fraction	Relative k
0 0181	3 62	0 0295	6 4
0 0119	2 69	0 0146	3 53
0 00593	1 99	0 00726	2 43
0 00296	1 74	0 00362	1 71
0	1	0	1

Since all these substances scarcely affect the absorption or fluorescence of eosine, the effect on the rate ought to be caused mainly by their interaction with the triplet state of the dye, or with any other species produced from it If one assumes, as has usually been done, that the triplet state is deactivated by the retarding substances (Q-groups), according to the process $D^t + Q \rightarrow D + Q$, then the relation

$$\frac{1}{k} = a + b[Q]/[R\text{H}] \qquad (3)$$

must hold approximately, where RH is ethanol

This fits the experimental results The effect of *n*-hexene and *cyclo*hexene is very specific in that the rate increases according to the relation (Fig 1)

$$k = a' + b' [P] \qquad (4)$$

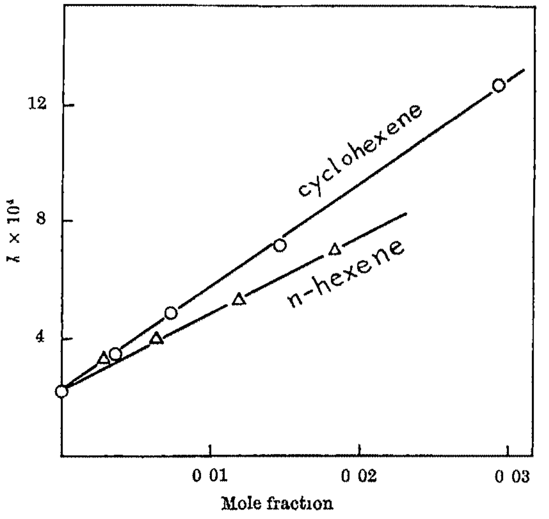

Fig 1 Plot of k against the concentration of the added substances

Assuming that these substances also attack the triplet state, then the above relation implies that the attack mainly results in the formation of semiquinone without any accompanying measurable deactivation process. This is rather curious in view of the behaviour of the Q group

Another possibility to be taken into consideration is that P attacks a complex between excited dye and ethanol, (D H—R), since the complex formation has now been confirmed by the flash experiments (preceding communication)

If one assumes that the two substances of the P group attack (D H—R) only in such a specific manner that R is detached from the latter, producing a more stable radical PR and leaving behind DH , then the rate of bleaching would be increased and the relation (4) can be accounted for

A definite conclusion must, however, await further work, especially by the flash technique, since the introduction of the complex has made it necessary to examine more carefully whether the added substances of the P group and also those of the Q group attack chiefly D^t or ($D \cdot$ H—R)

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CONTROL OF HATCHING IN THE PREDIAPAUSE EGGS OF *AEDES* MOSQUITOES

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EGGS of *Aedes* mosquitoes are usually laid above water-level, where they may remain viable for long periods while awaiting submergence On flooding, however, they do not usually all hatch together, even though they may all be the same age Indeed, hatching, even in continuously submerged eggs, may go on in small instalments over a period of many months This erratic hatching-response is well known, and results in a temporal spread of newly hatched larvæ—an obvious advantage to species which tend to utilize small collections of water subject to irregular changes in level and to sudden drying To the experimental worker, however, wanting large numbers of larvæ of the same age, erratic hatching is a nuisance Hence, much of the work that has been done on this subject has tended to ignore the biological significance of erratic hatching and has concentrated on a search for a stimulus that will make all eggs hatch together Many such stimuli have been described over the past forty years, and the references are too numerous to include here , suffice it to say that most of these involve a lowering of the amount of dissolved oxygen in the water[1] While it is obviously useful to know what can stimulate hatching in *Aedes* eggs, it is, perhaps, of greater biological interest to study the factors which inhibit it

It has previously been shown that, shortly after reaching embryonic maturity, unhatched but submerged and apparently hatchable eggs of *Aedes* (*Stegomyia*) *aegypti* (L) are overtaken by a state of genetically determined diapause, the depth of which varies with the passage of time, the manner of this variation with time itself varying from one egg to another[2,3] This obligate diapause differs in certain respects from many other instances of diapause[4,5] and can be broken at any stage by the application of a maximal stimulus[3] In Nature, however, it is probable that this strength of stimulus is never found, and hence only a few eggs hatch each time a stimulus occurs Thus, hatching by small instalments is ensured, once diapause has been entered The onset of diapause, however, does not always coincide with the attainment of embryonic maturity and a variable amount of hatching sometimes occurs before diapause has been reached Indeed, prediapause hatching is usual in *A* (*S*) *africanus* Theo , *A* (*S*) *apicoargenteus* Theo , *A* (*Finlaya*) *longipalpis* Grunb and in some strains of *A* *aegypti*[2]

In a strain of *A* *aegypti*, colonized in Entebbe, Uganda, in 1958, from eggs sent from Ilobi, Nigeria, by Mr J P T Boorman, prediapause hatching in a proportion of submerged eggs occurs on days 3 and 4 after laying , entry to diapause of the remaining unhatched eggs occurs on day 5, after which no further hatching occurs in the absence of a hatching stimulus The proportion which thus hatch during the prediapause state varies widely from one batch of eggs to another, all proportions having been recorded from 0 to 76 per cent Faced with this extreme degree of variability, it is a remarkable fact that never do they all hatch during the prediapause period It would appear that some mechanism comes into play which prevents unchecked hatching during this precarious period, thus ensuring that at least some eggs reach the diapause state It was postulated, therefore, that the first eggs to hatch might make conditions less favourable for the remaining unhatched eggs

In order to test this hypothesis it was first necessary to minimize variation by randomizing the eggs for parentage This was easily achieved by setting up a special colony of about 500 males and 500 females, reinforced by about 50 newly emerged adults of each sex per week, and making daily collections of the eggs which had been laid communally on a single small piece of moist filter paper When laying, the females do not deposit all, or even many, of the eggs in one place, but walk over the surface of the paper, stopping every few seconds to attach a single egg here and another there, and so on It follows that, by the time egg-laying activity is finished, which in this species is restricted to the last two or three hours of the daylight period[6], a mass of eggs results, any portion of which will be of mixed parentage It was taken as axiomatic that early-laid eggs usually reach embryonic maturity, and thus tend to hatch, before late-laid eggs, and the following account may be considered as an investigation into the possibility that hatching in early-laid eggs depresses hatching in late-laid eggs

Eggs laid on filter paper on a single day were carefully washed and submerged in tap water on the day of laying These are referred to as group *A* eggs For ease of handling and subsequent counting, the day's lay was arbitrarily divided into ten sub-groups by cutting the paper at convenient places—each piece of paper bearing approximately the same number of eggs Each piece was placed in a sterile glass tube containing 3 ml tap water 24 hr later the next day's lay was similarly treated (group *B*), but the pieces of paper bearing the eggs were placed in the tubes of water already containing the group *A* eggs Thus, each tube contained two pieces of paper bearing eggs, one (group *B*) being 24 hr younger than the other (group *A*) Both groups were kept submerged for five days at a temperature of 29° C and in constant light The papers bearing the eggs were removed on day 5 (group *A* on one day, group *B* on the following day), and the hatched eggs counted under a binocular dissecting microscope The papers were then placed in a medium containing a maximal stimulus for a period of 24 hr in order to test for viability of the unhatched eggs[3] The response was expressed as the number of eggs which hatched within five days, out of the total number of viable eggs present The result of this initial trial (combining the ten sub-groups) supported the hypothesis that hatching in early-laid eggs depresses hatching in companion late-laid eggs , 51 per cent of group *A* eggs hatched (226/440), 26 per cent of group *B* eggs hatched (126/478) Nevertheless, with such variable material, it was decided to make a total of ten such trials, with ten sub-groups in each The full results, including those of trial 1, are shown in Table 1, from which it will be seen that all the results are in the

Table 1 HATCHING IN SUBMERGED PREDIAPAUSE EGGS OF *A* *aegypti* INFLUENCE OF HATCHING OF EARLY-LAID EGGS (GROUP *A*) ON LATE-LAID EGGS (GROUP *B*), BOTH GROUPS SHARING THE SAME CONTAINER OF WATER

Trial No	Interval in hours between laying *A* and *B*	Group *A* Proportion hatched by day 5		Group *B* Proportion hatched by day 5		χ^2 ($n=1$)	Significance at 1 per cent level + or −
			Per cent		Per cent		
1	24	226/440	51	126/478	26	60 587	+
2	,,	209/476	44	172/534	32	14 659	+
3	,,	302/538	56	134/480	28	82 488	+
4	,,	250/635	39	122/502	24	28 914	+
5	,,	502/874	57	235/748	31	110 069	+
6	,,	210/278	76	78/292	27	135 827	+
7	,,	371/1,006	37	184/568	32	3 198	−
8	,,	202/298	68	192/686	28	137 705	+
9	,,	485/1,002	48	378/1,187	32	62 379	+
10	,,	276/440	63	169/411	41	38 897	+

Total 3,033/5,987 1,790/5,886

51 per cent 30 per cent

$\chi^2 = 504\ 515$

$P < 0\ 001$

Table 2 HATCHING IN SUBMERGED PREDIAPAUSE EGGS OF *A aegypti* INFLUENCE OF HATCHING OF EARLY-LAID EGGS (GROUP *A* TEST) ON LATE-LAID EGGS (GROUP *B* TEST), BOTH GROUPS SHARING THE SAME CONTAINER OF WATER CONTROLS (GROUPS *A* AND *B*) EACH IN CONTAINERS BY THEMSELVES

Trial No	Interval in hours between laying *A* and *B*	Group *A* Proportion hatched by day 5				χ^2 ($n = 1$)	Significance at 1 per cent level + or −	Group *B* Proportion hatched by day 5				χ^2 ($n = 1$)	Significance at 1 per cent level + or −
		Control		Test				Control		Test			
			Per cent		Per cent				Per cent		Per cent		
1	<2 >1	204/455	45	245/459	53	6 671	+	230/460	50	183/467	39	10 970	+
2	,,	273/529	52	268/577	47	2 952	−	239/492	49	209/477	44	2 028	−
3	24	274/543	51	258/472	55	1 786	−	220/579	38	163/533	31	6 758	+
4	,,	281/497	57	297/535	56	0 110	−	337/574	59	209/599	35	66 840	+
5	,,	235/476	49	270/472	57	5 842	−	223/453	49	189/384	49	0 056	−
6	,,	248/501	50	251/449	56	3 891	−	271/515	53	207/557	37	25 879	+
7	,,	270/572	47	263/526	50	0 858	−	242/563	43	173/598	29	24 939	+
8	,,	202/461	44	237/514	46	0 515	−	339/702	48	161/556	29	48 427	+
9	48	230/441	52	236/442	53	0 136	−	217/447	49	177/465	38	10 204	+
10	,,	272/548	50	267/609	44	3 890	−	365/718	51	145/546	27	75 959	+
Total		2,489/5,023 50 per cent		2,592/5,055 51 per cent				2,683/5,503 49 per cent		1,816/5,182 35 per cent			
		$\chi^2 = 2\ 995$ $0\ 05 < P < 0\ 10$						$\chi^2 = 205\ 813$ $P < 0\ 001$					

expected direction, the hatch in group *B* being significantly lower ($P < 0\ 001$) in every trial except trial 7

While these results are consistent with the hypothesis, they can, of course, be interpreted in the reverse way that the presence of group *B* eggs in some way enhanced the hatch in group *A* Therefore, a more critical experiment was planned using separate controls for groups *A* and *B* Eggs of group *A* were set up as test and control groups Similarly, eggs of group *B* were set up as test and control groups, group *B* test eggs being added to the water already containing the group *A* test eggs The response was expressed as the proportion of group *A* test eggs which hatched within five days compared with the proportion of group *A* control eggs which hatched in the same period, and the proportion of group *B* test eggs which hatched within five days compared with the proportion of group *B* control eggs which hatched in the same period Again, ten such trials were made with ten sub-groups in each trial, but the interval between the laying of groups *A* and *B* was varied from between 1 and 2 hr to 48 hr The results are shown in Table 2, and fully support the interpretation of the preliminary ten trials

These consistent and clear-cut results based on large numbers of eggs leave little doubt that the first eggs to hatch in some way influence the remaining unhatched prediapause eggs Now, prediapause hatching is spread over a period of about 24 hr on days 3–4, which is much longer than would be expected on the strength of the age differences in a mass of eggs laid in a single egg-laying period of 3 hr While some of this scatter probably owes its origin to innate variation on the part of the eggs themselves, it is perhaps increased by an influence from the first eggs to hatch It seems possible that as the number of early hatchers increases there is a progressive delay in hatching of the remaining eggs until further hatching is prevented by the onset of diapause on day 5 This preliminary interpretation receives some support from the results of a pilot trial Eggs obtained during a single egg-laying period were divided into three groups, *A*, *B* and *C* 24 hr later 100 and 1,000 newly hatched larvæ were added to groups *B* and *C*, respectively. The proportion of eggs which hatched in the three groups by day 5 was as follows group *A* (control with 0 larvæ) 362/678 (53 per cent), group *B* (100 larvæ) 323/673 (48 per cent), group *C* (1,000 larvæ) 270/721 (38 per cent) While these results are consistent with this view, and the differences are not only in the expected direction, but that between groups *B* and *C* is highly significant ($\chi^2 = 15\ 838, P < 0\ 001$), they would obviously have to be repeated many times before they could be accepted with confidence

There is no information yet on whether the influence results indirectly from metabolic contamination of the medium, or directly from the action of some specific diffusible hormone Preliminary trials have not shown any change in *p*H of the medium during this period, even when very large numbers of eggs are involved Some very interesting work has recently been done on the changes in permeability of the chorion in *Aedes* eggs which occur during the transition from the prediapause to the diapause state[7,8], and it would be interesting to know if these changes are affected by the presence of recently hatched larvæ in the medium

Contrary to these findings, some of the early work on egg-hatching in this genus indicated that the presence of larvæ may induce hatching in eggs kept in the same container[9,10] It is important to note, however, that these former results were obtained with eggs in the diapause state, in a later paper evidence will be presented which indicates that hatching in diapause eggs may, in fact, induce hatching in companion diapause eggs by lowering the threshold of response to a given stimulus Thus, whereas hatching in the prediapause state depresses further hatching, the reverse holds for diapause eggs

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ROLE OF A DAGGER NEMATODE (*XIPHINEMA* SP.) IN OUTBREAKS OF PLANT DISEASES CAUSED BY ARABIS MOSAIC VIRUS

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FOR many years arabis mosaic virus was solely of academic interest, having been found by Smith and Markham[1] only in a single plant of *Arabis* sp growing in an insect-proof glasshouse at Cambridge, England its natural mode of spread was unknown Recently, however, one of us (C H C, ref 2) has shown by serological tests that raspberry yellow dwarf virus, a soil-borne virus described in 1958 by Harrison[3], is closely related to and should be regarded as a strain of arabis mosaic virus Hence arabis mosaic virus clearly has a wide host-range, for raspberry yellow dwarf virus causes severe diseases in raspberry var Malling Exploit and in several strawberry varieties[3,4] It also occurs naturally in white clover and in several weed species[3], and it is one of several viruses involved[2] in the etiology of cherry diseases of the rasp-leaf type[5] Moreover, it has been found on the continent of Europe[2] as well as in widely separated parts of England, Scotland and Wales[3,6]

Little is known about the manner in which soil-borne viruses survive in soil and infect plants, but Hewitt, Raski and Goheen[7] have presented evidence that grape-vine fanleaf virus is transmitted by *Xiphinema index*, a large ectoparasitic, soil-inhabiting nematode with a long mouth-spear Infections with fanleaf virus occurred when *X index*, collected from soil around the roots of diseased grape plants, were transferred to pots of sterilized soil in which healthy grape plants were growing Moreover, the virus persisted with the nematodes when they were added to soil as much as 30 days before the grape plants[8]

Dagger nematodes (*Xiphinema* spp) were first recorded in Britain in 1959 They were found in Kent[9], in soil collected from the site of an outbreak of arabis mosaic virus in strawberry, and also on land cropped with white clover in Somerset[10] We too[11] have noted the presence together of *Xiphinema* and arabis mosaic virus at sites in Somerset and Pembrokeshire, and we now present the results of experiments in which the virus was regularly transmitted when dagger nematodes were present but not otherwise Very recently, Jha and Posnette[12] have also suggested that *Xiphinema* transmits this virus, for some healthy strawberry plants, growing in pots containing pasteurized soil, became infected when suspensions of dagger nematodes, from soil infested with arabis mosaic virus, were added to the pots

Distribution of *Xiphinema* in Crops affected by Arabis Mosaic Virus

Diseases thought to be caused by arabis mosaic virus were found in widely separated parts of Britain[6] Outbreaks in raspberry, strawberry and white clover were selected for detailed study of (*a*) the identity of the viruses involved, (*b*) the distribution of diseased plants, (*c*) the distribution of dagger nematodes, and (*d*) the infectivity of soil from diseased and healthy parts of crops

The viruses were identified serologically isolates from each of the sites listed in Table 1 precipitated specifically with an antiserum to arabis mosaic virus Diseased plants occurred in patches at all the sites Infected raspberry and strawberry plants showed typical symptoms, infected white clover plants usually had chlorotic blotches on their leaves The virus was consistently isolated from diseased plants but not from normal-looking plants growing outside the patches The soil samples were collected during a period of 12 weeks Aliquots (300 gm) of top-soil were used either to estimate the numbers of dagger nematodes present, or to grow a crop of pea seedlings (var Onward) in an insect-proof glasshouse Four weeks after sowing, the seedlings were washed free from soil and sap from their roots was inoculated to leaves of *Chenopodium amaranticolor* to find how many of the seedlings had become infected the proportion infected was taken as an estimate of the infectivity of the soil The dagger nematodes were extracted from the soil by a sieving technique similar to that described by Goodey[13] large pieces of plant debris were first removed from the muddy soil suspension and this then passed through a 50-mesh sieve, which retained *Xiphinema* The material

Table 1 ASSOCIATION OF *Xiphinema* WITH OUTBREAKS OF DISEASES CAUSED BY ARABIS MOSAIC VIRUS

Locality	Crop	Soil type	No *Xiphinema* per 300 gm soil	Infectivity of soil*
Methwold, Norfolk	Raspberry (*a*) healthy area	Black peat fen	0	0/2
	(*b*) diseased area	Black peat fen	12	8/8
	(*c*) diseased area	Black peat fen	27	—
Tenby, Pembrokeshire	Strawberry (*a*) healthy area	Heavy loam	0	0/7
	(*b*) diseased area	Heavy loam	4	5/6
Fareham '*A*' Hampshire	Strawberry (*a*) healthy area	Light shingle	1	0/3
	(*b*) diseased area	Light shingle	34	4/5
Fareham '*B*', Hampshire	Strawberry (*a*) healthy area	Light shingle	0	0/8
	(*b*) diseased area	Light shingle	9	7/10
Crewkerne, Somerset	White clover (*a*) healthy area	Moist sandy loam	0	—
	(*b*) diseased area	Moist sandy loam	35	2/3

* Five pea seedlings were grown for 4 weeks in each 300-gm aliquot of soil The incidence of virus infection was then determined by inoculating sap from the pea roots to leaves of *Chenopodium amaranticolor* Numerator is the number of lots of soil in which pea seedlings became infected, denominator is the total number

Table 2 EFFECT OF CHEMICAL TREATMENTS ON THE NEMATODE POPULATION AND INFECTIVITY OF SOIL

Chemical added to soil*	No *Xiphinema* per kgm soil 6 weeks after treatment†		No living 'small nematodes'‡ per kgm soil 6 weeks after treatment	Infectivity of soil§ (No pots containing infected seedlings)
	Living	Dead		
None	21	0	5,029	8/12
Ethylene dibromide (0 4 ml /litre soil)	0	0	1	0/12
Pentachloronitrobenzene (1 gm 20 per cent dust/litre soil)	0	5	4,608	0/12
Tetramethylthiuramdisulphide (2 gm 10 per cent dust/litre soil)	0	24	272	0/12

* The mixtures of soils and chemicals were stored in sealed tins for 2 days They were then potted and pea seeds (5 per pot) planted after a further 2 days Pentachloronitrobenzene and tetramethylthiuramdisulphide dusts were provided by the Murphy Chemical Co

† Before treatment the soil contained about 36 *Xiphinema* per kgm soil

‡ 'Small nematodes' includes all nematodes that passed through a 50-mesh sieve but were retained on a 160-mesh sieve

§ Six weeks after planting, the incidence of infection in the pea plants was estimated as described in Table 1 Numerator is the number of pots containing infected seedlings and denominator is the total number of pots used

extracted on the sieve was examined in a syracuse dish under a binocular microscope This method was shown to recover at least 75 per cent of the *Xiphinema* in the soil

Table 1 gives results for a selection of sites, and shows that, although arabis mosaic virus was previously recorded only in soils of medium-heavy texture[4], it is not restricted to these, and that serious disease outbreaks also occur on black fen and shingle soils[6] All the samples from soil inside patches of diseased plants were infective and all contained *Xiphinema*, whereas soil from outside such patches was not infective and, with one exception, did not contain *Xiphinema* At the exceptional site, Fareham '*A*', a single dagger nematode was found in 300 gm soil collected outside the diseased area Each population of dagger nematodes contained both larvæ and adults, but the proportion of adults varied from less than 5 per cent to 30 per cent at different sites The total numbers of *Xiphinema* varied considerably between sites but were never large, suggesting that if dagger nematodes are involved in virus transmission, only a few are needed to enable the soil to become highly infective Indeed, the numbers recovered from five 300-gm lots of Fareham '*B*' soil, in each of which pea seedlings had become infected, were 3, 4, 5, 9 and 10, respectively · 5, 9 and 17 *Xiphinema* were isolated from three similar lots in which the seedlings had remained healthy Soils collected from under diseased plants at several additional sites all contained *Xiphinema*

Tests with Isolated Dagger Nematodes

Results of soil fractionation experiments, in which infective soil was suspended in water and then passed successively through 25, 50 and 160-mesh sieves, showed that each sieve retained infective material but that the fraction of soil passing through the 160-mesh sieve was not infective The distribution of infectivity roughly paralleled that of the dagger nematodes Other tests showed that soil extracts of the type used for counting *Xiphinema* (made using a 50-mesh sieve) conferred infectivity on sterilized soil Attempts were therefore made to separate the dagger nematodes from the other animals and materials in these extracts The extracts were thoroughly washed on a 160-mesh sieve, re-suspended in water, the dagger nematodes were picked out with a wire handling-needle and transferred, first to watch-glasses containing distilled water, and then to pots containing virus-free soil The extract residues were added to other similar pots of soil All the pots were planted with peas, which were tested for the virus four weeks later No plants growing in virus-free soil or in soil to which the extract residues had been added became infected, but plants growing in soil infested with hand-picked *Xiphinema* did In three experiments, in which 15–20 dagger nematodes were added to each pot, 2 out of 11, 4 out of 12 and 1 out of 13 pots contained infected pea seedlings In one experiment the dagger nematodes were separated, in batches of 20 into adult males, adult females and larvæ Infection occurred with each of two batches of males, with two out of three batches of females but with none of six batches of larvæ In a second similar experiment, infection occurred with two out of sixteen batches of larvæ but with none of twelve batches of adults Serological tests on several of the virus isolates from pea seedlings exposed to hand-picked *Xiphinema* confirmed that each was arabis mosaic virus Isolates from plants exposed either to male or to female *Xiphinema*, or to larvæ, were among those identified serologically

Chemical Treatment of Infective Soil

The infectivity of soils containing tomato black ring virus is abolished by treatment with each of several different chemicals, some of which seem to have little or no effect on infectivity of the virus *in vitro*[11] Table 2 shows the result of treating soil containing arabis mosaic virus with some of these substances After peas had been grown in them for six weeks, no living dagger nematodes were found in any of the soils treated with chemicals, and from the fact that no plant growing in these soils became infected, it seems probable that the *Xiphinema* were either killed quickly or deterred from feeding on the plants Table 2 also contains two other items of note First, many dead *Xiphinema* were found at the end of the experiment in soil treated with tetramethylthiuramdisulphide, suggesting either that they had died only recently or that the chemical had prevented their decomposition Secondly, although counts of other large eelworms, for example, *Dorylaimus* spp , paralleled those for *Xiphinema*, pentachloronitrobenzene (and in some experiments tetramethylthiuramdisulphide) seemed, at the doses used, to have little effect on the numbers of 'small eelworms' (all eelworms that passed through a 50-mesh sieve but were retained on a 160-mesh sieve) In the soil, these chemicals appear to have differential effects on different kinds of nematodes

Air-drying soil at 20° C for a week is another treatment that abolishes the infectivity of soil containing arabis mosaic virus[11] Here again, the effect is most plausibly explained by the treatment killing *Xiphinema*, for after a week of air-drying, only 25 dagger nematodes, all dead, were isolated from 1 kgm of soil, whereas 64, all alive, were found in a similar lot kept moist

Conclusions

Throughout our work the infectivity of soils and of preparations from soils has been correlated with the presence of living dagger nematodes Moreover, the fact that *Xiphinema* was absent or rare outside patches of diseased plants suggests that the nematodes are often the limiting factor in the spread of arabis mosaic virus We have found *Xiphinema* only in fields where arabis mosaic virus occurs

In the soils we have used, arabis mosaic virus seems associated only with the dagger nematodes Neither the residue left after their removal from infective extracts, nor the material passing through a sieve which retained the dagger nematodes, was infective All the evidence points to *Xiphinema* as being the vector of arabis mosaic virus, and it may seem unnecessarily cautious to mention the possibility that the virus could be associated with the nematodes in such a way that they are not acting as virus vectors in the usual sense The evidence for virus transmission by the nematodes is as good as, but no better than, that commonly accepted as indicating that insects are vectors of plant viruses If dagger nematodes are virus vectors in the usual sense, a role for which they seem well fitted, it is clear that they can be quite efficient For example, the tests made on infective soil from Tenby (Table 1) suggest that about 1 in 3 of the dagger nematodes transmitted the virus Then again, in one of the experiments with hand-picked dagger nematodes, an estimated 1 in 12 of adults transmitted the virus, despite the probability that the soil and environmental conditions were not optimal for them Although we found there was no need to provide the nematodes with fresh sources of virus, had this been done, the rates of transmission by hand-picked nematodes might have been higher This possibility, and the mechanism of virus transmission, are the subject of further investigations

Losses of crop from arabis mosaic virus can probably be avoided in raspberry by growing immune varieties, such as Malling Jewel[14], but it is uncertain whether other crop species also contain immune varieties However, if dagger nematodes spread the virus, additional methods of control seem possible The results of treating soils with chemicals show that *Xiphinema* is as sensitive to them as are some small plant-parasitic nematodes[11], possibly more so, for dagger nematodes were killed by the action of some substances commonly used as fungicides and not as nematicides The fact that many soils contain only relatively few *Xiphinema* also encourages the view that soil nematicides will be effective in controlling the diseases The problem is now a practical one, namely, to incorporate the nematicide into soil sufficiently evenly and to a sufficient depth to ensure a high percentage kill of the population at an economically acceptable cost

The taxonomic status of the dagger nematode used in our experiments is still being studied in detail, but preliminary results (Goodey, J B , Peacock, F C , and Pitcher, R S , unpublished observations) suggest it is closely related to, and possibly identical with, *Xiphinema diversicaudatum* Micoletzky, and thus differs from the one associated with grape vine fanleaf virus in California[7] Whether the two viruses are serologically related is unknown, but fanleaf virus has not been transmitted to species outside the Vitaceae or by mechanical inoculation of sap But even if these two viruses are closely related, they are unlikely to be the only ones the spread of which depends on soil-inhabiting nematodes Indeed, evidence was recently advanced that the transmission of peach yellow bud mosaic virus is associated with *Xiphinema americanum*[15] Several viruses resemble arabis mosaic virus in possessing a wide host-range, in the type of symptoms they cause, in their *in vitro* properties[14,16] and in having isometric particles of approximately 25 mμ diameter (Harrison, B D , and Nixon, H L , unpublished observations) With one of these viruses, tomato black ring, there is already evidence that an agent in soil plays a part in virus transmission[11], and it is among such viruses that additional nematode-transmitted types seem most likely to be found

We are much indebted to Dr J B Goodey for advice and for permission to refer to his unpublished work

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ULTRACENTRIFUGATION AND STAINING OF *HEVEA* LATEX

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COOK AND SEKHAR, in 1953[1], described the separation of *Hevea* latex into phases by high-speed centrifugation and interpreted their results in terms of the types of particle which had been found by various earlier workers in latex after collection from the tree In particular, the sedimented material was considered to represent an aggregation of the lutoid particles discovered by Homans and van Gils[2] Cook and Sekhar's method has been used continually in these laboratories in the preparation of latex fractions for chemical and enzymological investigations[3], and there is no doubt as to the general correctness of their conclusions However, more recent observations seem to show that the sedimentable material in latex cannot consist wholly of one species of particle, and that the non-sedimentable components of latex are also more complex than was thought hitherto A short account of these observations seems

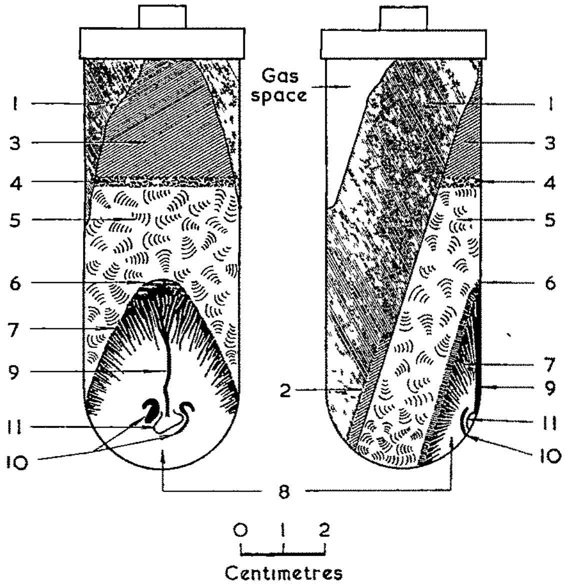

Fig 1

timely , there is current interest in the biochemistry of *Hevea*[3-6] and high-speed centrifugation of latex is being used in other laboratories besides our own[4]

In the present work, latex was obtained from a small stand of buddings of the clone Prang Besar 186 of *Hevea brasiliensis* These trees were mature and had been tapped by the half-spiral alternate-daily system[7] for many years The latex was collected for 30 min after tapping, into glass vessels kept in ice baths It was centrifuged at 53,620g(max) for 40 min in Rotor No 21 (prechilled to 0°) of a Spinco Model *L* ultracentrifuge The temperature of the latex thus fell to 0–5° C soon after leaving the tree and remained in this range virtually throughout the fractionation Such close temperature control was not used in the earlier work cited[3], although this point is not always clear in the published accounts

Fig 1 shows diagrammatically the separated zones regularly observed after centrifugation Two views of a single tube are shown , these are not cross-sections, but approximate plane projections of the pattern visible from outside the tube The various zones were distinguishable by colour or texture or both , in a series of experiments extending over ten weeks some variation in detail occurred, but the main features of the pattern were surprisingly reproducible Further definition of the zones and some indication of their possible cytological significance were obtained by treating the latex with trace amounts of janus green *B* or neutral red before centrifugation This procedure produced a pattern which seemed to correspond in all essential respects with that formed from unstained latex, and it thus appeared that the stains do not significantly affect the sedimentation behaviour of the particles present

A full description of the appearance of each of the eleven zones, as observed with and without pre-staining the latex, would be rather voluminous Only the major points will be mentioned here

Zone 1, which is white and opaque, though shaded in the diagram, corresponds with the 'top white fraction' of Cook and Sekhar[1] The much smaller zone, 2, is distinguished from it by a certain translucence and, in latex pretreated with janus green *B* by a bright blue colour (Janus green *B* staining is barely perceptible in zone 1) Zone 3, a white emulsion, appears cognate with zone 2, since it also stains blue with janus green *B* and on more prolonged centrifugation it is reduced in amount while zone 2 is increased Zone 4 (orange) is the 'yellow-orange layer' of Cook and Sekhar[1] , the aqueous zone 5 corresponds with the 'C serum' of earlier literature[3] and zones 6–11 are together broadly equivalent to 'bottom fraction' However, in this connexion it should be noted that the effects of the fully refrigerated technique are considerable in our experiments zone 5 was turbid, and the sedimented material (6–11) was semi-liquid If centrifugation is conducted at higher temperatures as in previous work[3], the serum is clearer and the sediment more nearly solid , the stratification of the latter is also less sharp

Zone 6 is a loose whitish layer on the upper plane of the sediment Agitation re-disperses it largely into zone 5, where it assumes the same ropy texture as the turbidity initially present Prolonged ultracentrifugation of zone 5 at about 140,000g(max) deposits a small gelatinous sediment which gives a positive test for pentose (orcinol reaction)

Zone 7, embedded in the face of zone 8, contains both yellow and whitish material and is unstained by neutral red With janus green *B* the colour of the zone is at first ill-defined, varying from yellowish to dirty green However, when the tube and contents are allowed to warm to 20–25° after centrifugation, the zone becomes bright red

Zone 8, which accounts for the bulk of the sediment, is practically a gel at 0–5°, is greyish-cream in colour and becomes syrupy at room temperature From latex pre-treated with neutral red it is intensely pink and contrasts very strikingly with the unstained zone 7

Zone 9 is a streak of material resembling zone 7 in appearance and staining reactions, but more strongly sedimented It joins zone 7 at the upper end of the pellet, and no clear boundary can be drawn Zone 10 is a ring of deep orange material, and zone 11 a speck of translucent greyish jelly These last two are minute in amount but their presence is generally quite unmistakable

All the above results refer specifically to Prang Besar 186 latex, but preliminary experiments on other latexes indicate a similar complexity Of the particles known to be present in latex after collection, lutoid particles are, by definition[2], readily sedimentable Also Wiersum[8] has reported that they stain with neutral red (under the microscope) It therefore seems that my zone 8 must contain these particles, a conclusion readily reconcilable with that of Cook and Sekhar Similarly, zone 1 must still be ascribed to rubber particles and zone 4 to Frey-Wyssling particles[9], as by these authors

Collected latex also contains bacteria our samples gave viable counts in the range 10^5 to 5×10^6 organisms per ml , by the method of Taysum[10] The total volume of bacteria in one centrifuge tube of latex (90 ml) would probably be small

To explain the observations outlined above, even partially, it seems necessary to postulate the presence in latex, in addition to the particles already mentioned, of the following (1) a variety of particle staining blue with janus green *B* and migrating centripetally (zones 2 and 3) , (2) at least one species of particle which sedimented with difficulty (zone 6 ; further centrifugation of zone 5) , (3) at least one species of particle reducing janus green *B* (zones 7 and 9)

A more complete explanation would necessarily be speculative; my purpose at this stage is primarily to direct attention to the complexity of collected *Hevea* latex. However, it should ultimately be possible to relate the particulate components of the latex to the normal concepts of plant cytology. With this intention, Wiersum[8] has published evidence suggesting that 'lutoids' may be considered as the elements of a polydisperse vacuome. In my observations the component sedimented with difficulty has suggestive similarities to the particulate ribonucleoprotein ('microsomes') now well known in animal cells and also reported in higher plants[11]. Further, McMullen[3] has recently detected ribonucleoprotein in freeze-dried latex serum. The reaction of zones 7 and 9 with janus green is essentially the same as that reported for liver mitochondria by Recknagel[12] using a closely similar experimental method. Reactions with janus green must, of course, be interpreted with reserve, especially perhaps in the presence of bacteria.

It should also be possible to relate the components of collected latex to the cytology of the laticifers *in vivo*. The existing literature on this subject, reviewed by Wiersum[8] and Milanez[13], is somewhat controversial, and very little is known of the cytology of latex vessels submitted to regular tapping. Milanez considers that in intact vessels latex is homologous with cytoplasm and not with vacuolar sap, as in the traditional opinion[14], and he has also reported the presence of mitochondria. If these views are applicable to latex collected by tapping, the complexity of latex revealed in the centrifuge would find an explanation.

I am indebted to Mr. W. G. Wren for advice and encouragement, to Ir. P. de Jonge and Mr. D. H. Taysum for valuable discussions and to the last-named also for all bacteriological data and for access to his unpublished microscopic studies on latex. I acknowledge also the technical assistance of Mr. Yap Chin Fah and Mr. Hoh Lian Yong, as well as translations by Dr. J. K. Templeton, Mr. N. G. Bissett and Ir. E. C. Paardekooper. This work, which is continuing, forms part of a programme of research undertaken by the Board of the Rubber Research Institute of Malaya.

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GLYCOPROTEINS OF HUMAN CEREBROSPINAL FLUID

By DR. SAMUEL BOGOCH

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WHILE the cerebrospinal fluid is the only compartment of the central nervous system which can readily and repeatedly be sampled in both man and animals without unphysiological effects, relatively few quantitative data are available on its organic constituents[1]. Micromethods have been developed in this laboratory which permit the analysis of small quantities of cerebrospinal fluid with special reference to the carbohydrate and protein constituents. A total of 236 individual specimens of cerebrospinal fluid have been examined by these techniques.

10–30 c.c. aliquots of lumbar cerebrospinal fluid are immediately lyophilized, quantitatively dialysed in 'Cellophane' at 4° C. against glass-distilled water to completion, with the result that three major fractions are obtained[2,3]: Fraction *G* (non-dialysable, water-soluble in conditions of vanishing ionic strength), Fraction *P* (non-dialysable, water-insoluble), Fraction II (dialysable). Both the original unfractionated cerebrospinal fluid and the resultant subfractions have been quantitatively analysed for total solids, nitrogen, phosphorus, hexose, hexosamine and reducing sugar. In addition, it has been possible by this method to obtain accurate values for the presence of true neuraminic acid in cerebrospinal fluid, since that which is associated with non-dialysable fractions has been freed from the interference of dialysable monosaccharides, and the neuraminic acid which is unbound and dialysable, when present, can be detected by the use of column chromatography ('Amberlite *IRC*-120' for sodium ions, followed by 'Dowex-3-*OH*' for chloride ions, then 'Dowex-1-formate' for neuraminic acid) to separate it from the large excess of monosaccharides present, and by the thiobarbituric acid reaction[4,5]. The values of total neuraminic acid have been found to vary from 2 to 29 μgm./c.c. of whole cerebrospinal fluid, with from 0 to 12 μgm. of the total representing free neuraminic acid. The previous use of the Bial reagent to measure total neuraminic acid in whole cerebrospinal fluid[6,7] gave a somewhat higher range of values due to monosaccharide interference. Individual differences in the concentration of neuraminic acid in cerebrospinal fluid were detected with the Bial reagent, despite the large interference by monosaccharides, because most of these differences have been shown to be the result of variation in the concentration of Fraction *G* neuraminic acid[2].

Table 1 MOLAR QUANTITIES AND RATIOS OF HEXOSE, HEXOSAMINE AND NEURAMINIC ACID IN FRACTION *G* OF INDIVIDUAL SPECIMENS OF CEREBROSPINAL FLUID

Total solids in Fraction *G* (mgm /c c) cerebrospinal fluid	Molar ratios			Molar ratio
	Hexose (as glucose)	Hexosamine (as galactosamine)	Neuraminic acid	Hexose Hexosamine
0 338	1 4	5 6	1	0 25
0 331	1 8	2 8	1	0 65
0 490	3 5	5 2	1	0 69
0 530	1 3	1 8	1	0 72
0 616	2 9	3 8	1	0 76
0 320	3 8	4 8	1	0 79
0 658	2 7	3 0	1	0 90
0 450	3 2	3 6	1	0 91
0 314	2 2	2 2	1	1 00 (1 1)
0 734	2 7	2 7	1	1 00
0 292	3 7	3 5	1	1 06
0 323	3 4	3 1	1	1 10
0 275	4 7	4 1	1	1 15
0 335	3 8	3 2	1	1 19
0 159	4 6	3 9	1	1 18
0 371	3 6	3 0	1	1 20
0 499	4 2	3 4	1	1 24
0 150	4 5	3 6	1	1 25
0 274	5 0	3 8	1	1 32
0 178	2 9	2 0	1	1 45
0 278	7 4	4 2	1	1 76
0 428	6 9	3 9	1	1 76
0 403	5 4	2 8	1	1 93 (2 1)
0 192	5 0	2 3	1	2 17
0 308	5 7	2 6	1	2 19
0 424	6 2	2 8	1	2 22
0 179	3 2	1 4	1	2 28
0 345	4 3	1 9	1	2 30
0 354	14 4	6 2	1	2 32
0 434	6 1	2 6	1	2 34
0 403	6 6	2 7	1	2 44
0 374	10 3	3 6	1	2 80
0 187	5 0	1 7	1	2 94
0 425	9 9	3 3	1	3 00 (3 1)
0 543	7 7	2 4	1	3 20
0 296	3 3	1 0	1	3 30
0 278	34 4	9 9	1	3 48
0 538	5 3	1 3	1	4 07 (4 1)
0 142	8 7	2 1	1	4 20
0 480	6 1	1 1	1	5 55
0 276	6 7	1 1	1	6 09 (6 1)
0 428	13 6	2 2	1	6 18
0 594	6 7	0 7	1	9 58 (10 1)

All the hexosamine in cerebrospinal fluid has been shown to be non-dialysable, most of it being associated with Fraction *G* The absolute quantities of hexosamine (as galactosamine) range from 1 7 to 60 1 μgm / c c whole cerebrospinal fluid (mean 14 4) Fraction *G* hexose (as glucose) has similarly been shown to vary from 4 0 to 88 3 μgm /c c whole cerebrospinal fluid (mean 25 7) The distributions of the constituent hexose and neuraminic acid have been studied in electrophoretic subfractions of Fraction *G* and have been shown to be associated mostly with α_2- and α_1-globulin fractions, with some samples showing the greatest concentration of these constituents in the β-globulin fraction

Optimal conditions have been established for the hydrolytic release of the constituent carbohydrates of Fraction *G* Utilizing 0 08 *N* hydrochloric acid hydrolysis at 100° C for 20 min , 65 per cent of the original neuraminic acid of the macromolecular fraction was released in dialysable form, together with 60 per cent of the original hexosamine, but only 8 per cent of the original hexose Comparison of these results with the hydrolytic behaviour of brain ganglioside[8] suggests that in the cerebrospinal fluid glycoproteins, as in brain ganglioside, the neuraminic acid and hexosamine moieties are more peripherally located or at least more available to mild acidic hydrolysis than are the hexose moieties Further experiments utilizing 2 *N* hydrochloric acid for different periods of time resulted in the selective liberation of the hexoses, galactose having been shown to be released before mannose Application of these methods to the structural determination of purified cerebrospinal fluid glycoprotein fractions separated by column chromatography is in progress The structural relationship of these carbohydrate constituents is of interest with reference to their membrane, receptor and transport functions demonstrated in other studies in this laboratory[9-11]

The quantitative determination of neuraminic acid, hexosamine and hexose has permitted an examination of the molar ratios of these substances in individual cerebrospinal fluid specimens Rather than finding reasonably uniform molar ratios, wide individual variation has been demonstrated in the ratios hexose hexosamine neuraminic acid, ranging from approximately 1 1 1 to 10 1 1 Table 1 shows a few examples of the variation observed both in absolute amounts of these constituents and in their relative ratios That this variation is not a function of the total amount of Fraction *G* present per c c of cerebrospinal fluid is also shown in Table 1 The total content of solids in cerebrospinal fluid has been shown to tend to increase with age after the second decade The concentration of hexosamine derived from Fraction *G* increases during the same period The concentration of hexose derived from Fraction *G* also increases during this period, but even more greatly than does hexosamine The specific increment of hexose to hexosamine appears to be more marked in the third and fourth decades, the molar ratios of these constituents tending to approach unity after the fifth decade

The possible biological significance of unusual total concentrations of macromolecular hexose, hexosamine and neuraminic acid, as well as of unusual molar ratios and electrophoretic distributions of these substances in cerebrospinal fluid in relation to different neuropsychiatric disorders, is considered elsewhere[12] Perhaps most significant is the fact that there has been demonstrated great individual variation both in the absolute quantities and in the relative ratios of particular carbohydrate constituents of cerebrospinal fluid glycoproteins Whether this potential for individual variation reflects genetically determined normal characteristics or specific chemical patterns of particular functional or disease processes, or both, is yet to be determined The possibility exists that an opportunity is indicated by means of similar studies on other compartments of the nervous system for the definition of chemical bases of individuality

These studies, to be presented in detail elsewhere[13], have been supported in part by grants from the National Institutes of Health (*B*-1221 and *M*-2095) and the Scottish Rite Research Committee, National Association for Mental Health (U S)

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 14

Institution of Electrical Engineers (at Savoy Place, London, W C 2), at 5 30 p m —Discussion on 'Why Hi-Fi ?", opened by Mr P P Eckersley

Society of Chemical Industry, Pesticides Group (at 14 Belgrave Square, London, S W 1), at 5 30 p m —Mr P B Cornwell "Insect Control by Gamma Irradiation"

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 8 30 p m —Baron G de Gerlache de Gomery "The Belgian Antarctic Expedition"

Tuesday, December 15

Institute of Marine Engineers (at the Memorial Building, 76 Mark Lane, London, E C 3), at 5 30 p m —Mr K Maddocks "Some Aspects of Marine Reactor Security"

Institute of Physics (at 47 Belgrave Square, London, S W 1), at 5 30 p m —Mr K G Freeman "Tubes for Colour Television"

Institution of Electrical Engineers, Measurement and Control Section (at Savoy Place, London, W C 2), at 5 30 p m —Discussion on "Data Handling Problems in Atomic Installations", opened by Dr D Taylor

Wednesday, December 16

Powder Metallurgy Joint Group of the Iron and Steel Institute and the Institute of Metals (in the Hoare Memorial Hall, Church House, Great Smith Street, London, S W 1), at 9 30 a m —Symposium on "The Powder Metallurgy of Magnetic Materials"

Royal Meteorological Society (at 49 Cromwell Road, London, S W 7), at 5 p m.—Dr H Wexler "Seasonal and other Temperature Changes in the Antarctic Atmosphere", Mr W Hitschfeld "Patterns of Hailstorms in Alberta"

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 5 15 p m —Sir Hugh Beaver, K B E "Statistics as a Tool of Management" (Presidential Address)

Institute of Petroleum (at 61 New Cavendish Street, London, W 1), at 5 30 p m —Mr A C Hartley "Pipelines"

Institution of Mechanical Engineers (at 1 Birdcage Walk' Westminster, London, S W 1), at 6 p m —Dr S G Hooker "The Future of Air Breathing Engines in Aviation" (James Clayton Lecture)

Society of Chemical Industry, Corrosion Group (at 14 Belgrave Square, London, S W 1), at 6 p m —Discussion of Research Papers recently published by Members of the Group

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W 1), at 7 p m —Mr J F Coales "Random Inputs and Load Variations"

Thursday, December 17

British Computer Society, London Branch (at the Northampton College of Advanced Technology, St John Street, London, E C 1), at 2 30 p m —Discussion on "Conversion between Analogue and Digital Representation".

Society of Chemical Industry, Road and Building Materials Group (at 14 Belgrave Square, London, S W 1), at 2 30 p m and 5 30 p m —Scientific Papers

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Dr A J Robinson "Relationship Between Particle Size and Collector Concentration", Mr D Borchers "Deepening of No 1 Vertical Shaft at Premier (Transvaal) Diamond Mining Co , Ltd "

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Prof E V Schenkman "Supersolvable Groups"

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, London, W C 2), at 6 p m —Discussion on "The Presentation of the History and Philosophy of Science", opened by Prof H Dingle

Thursday, December 17—Friday, December 18

Physical Society (in the Townsend Lecture Theatre, The Clarendon Laboratory, Oxford), at 10 a m daily—Conference on "Electron-Phonon Interaction in Solids"

Friday, December 18

Society of Chemical Industry, Fine Chemicals Group (at 14 Belgrave Square, London, S W 1), at 6 30 p m —Dr F E Camps "Some Aspects of Forensic Science"

Friday, December 18—Saturday, December 19

British Psychological Society (at University College, Gower Street, London, W C 1)—Conference

Saturday, December 19

Biochemical Society (in the Department of Chemical Pathology, King's College Hospital Medical School, Denmark Hill, London, S E 5), at 10 30 a.m —389th Meeting

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturer (with a good honours degree and teaching experience) in Chemistry at the Nigerian College of Arts, Science and Technology—The Council for Overseas Colleges, 12 Lincoln's Inn Fields, London, W C 2 (December 21)

Technician or Senior Technician in the Department of Pathology, University of Khartoum—The Registrar, University of Khartoum, c/o Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (December 22)

Lecturer in Mathematics in St Salvator's College—Joint Clerk to the University Court, College Gate, St Andrews (December 31)

Lecturer in Statistics in St Salvator's College—Joint Clerk to the University Court, College Gate, St Andrews (December 31)

Lecturer (with a special knowledge of, and interest in, the vertebrates) in Zoology—The Registrar, King's College (University of Durham), Newcastle-upon-Tyne 1 (December 31)

Scientific Officer (with a first- or second-class honours degree in civil engineering or physics, or equivalent qualifications) at the Hydraulics Research Station, D S I R , Howberry Park, Wallingford, Berks, for studies of hydraulic problems in the field of civil engineering, including scale model investigations—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting E 489/9A (December 31)

Technician (preferably with experience in a laboratory concerned with the physiology, biochemistry or the culture of micro-organisms) in the Botany Department, University of Canterbury, New Zealand —The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (December 31)

Senior Lecturer in Clinical Biochemistry at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (January 4)

Senior Lecturer (with main interest and special qualifications in the field of petrology) in Geology at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (January 4)

Reader in Physiology at Middlesex Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W C 1 (January 20)

Assistant Lecturers (with at least a good honours degree in physics, and preferably experience in teaching and/or research) in Physics at the University of Malaya, Kuala Lumpur—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1

Biochemist, Basic grade (with a first- or second-class honours degree in chemistry or biochemistry) in the University Department of Medicine, Glasgow, for research work—The Secretary, Royal Infirmary, 84 Castle Street, Glasgow, C 4

Isotope Technician (preferably with a knowledge of biochemistry or electronics) for work in a specialized laboratory dealing with diagnosis, treatment and research in thyroid disorders—The Secretary, New End Hospital, Hampstead, London, N W 3

Lecturer in Veterinary Anatomy at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, February 27)

Master to teach Mathematics up to advanced level, with possible scholarship work—The Headmaster, Tonbridge School, Tonbridge, Kent

Specialist Superintendent (Chemist) (with a university degree in chemistry or agricultural chemistry, the higher national certificate in chemistry, or the diploma of the Science Technologists Association, or equivalent qualifications) in the Department of Agriculture, Northern Region of Nigeria, to be responsible for the organization, supervision, and general running of the Chemistry Laboratories at Samaru, and also to undertake certain determinations for research projects—The Director of Recruitment, Colonial Office, London, S W 1, quoting BCD/63/408/018/T

Technician (female, with manual dexterity for preparing small fossils) in the Zoology Department—The Secretary, University College London, Gower Street, London, W C 1, quoting Ref No Zoo/4

REPORTS and other PUBLICATIONS

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SECONDARY AND HIGHER EDUCATION IN BRITAIN

A PAPER entitled "A Policy for Higher Education", published as a special supplement in *Socialist Commentary* of September over the signatures of Mr Robin Morris as chairman, J Vaizey and A H Halsey as rapporteurs, the co-signatories including Prof W J M Mackenzie and M Stewart, M P , is the outcome of three conferences of people from different but appropriate professions, and while representing a compromise between various lively points of view, it is intended as a basis for further discussion It supports the idea of a Royal Commission on institutions of higher education in Britain, but emphasizes the importance of prior thinking if such a Commission is to be effective, and also urges that any such Commission should consider the whole field of higher education rather than concentrate on the universities themselves The paper is not itself concerned directly with secondary education, but its signatories are agreed as to the need for considering carefully the interactions of secondary and higher education

The primary objective of the paper appears to be to ensure equality of opportunity in education, and the writers recognize that this must be based on equality of opportunity in secondary education The argument and implications of Michael Young's essay, "The Rise of the Meritocracy", are clearly in mind, and in the phrase 'equality of opportunity' the last word is generously interpreted One of the major recommendations—the amalgamation of teacher training colleges and colleges of technology into colleges of liberal arts and technology enjoying the autonomy and relation to the community which characterizes the universities proper, and administered by a body analogous with the University Grants Committee but in touch with the work of the local authorities in this field—is intended to meet this need Nevertheless, the paper appears to be somewhat doctrinaire and would have been more convincing had it been based on a thorough and impartial inquiry into some of those matters such as the size of classes, the effect of lengthening the period of compulsory schooling at one end rather than the other, the advantages or disadvantages of large schools as against co-education and of training teachers for three years consecutively, which, in the absence of precise knowledge, are liable to be the sport of political theory or prejudice

On the expansion of higher education, a target of 300,000 full-time students by 1970 is recommended, and of these about one-third should be in technical and teacher training colleges This would involve an increase of 6 or 7 per cent per annum in the number of teachers if present staffing ratios are to be maintained, and in this context it is recommended that improvement of the economic position and status of teachers in universities and institutions of higher education (outside Oxford and Cambridge) is essential The report recommends less specialization at school, but while the signatories may well be right in suggesting that some sixth-form teachers would be more advantageously employed in a college or university, the proposal to shift educational effort from the sixth form to the university is more debatable, and should be based on facts—some of which have still to be determined—rather than theory The economics of any such step are dubious and also its social consequences, quite apart from whether it is really consistent with the true functions of a university

To some extent that is also true of the recommendation that expansion of the provincial universities of Britain should be accompanied by rising standards in staffing ratios, salary scales, buildings, halls of residence, etc , directed at bridging the gap between 'Redbrick' and 'Oxbridge' Heavily increased expenditure on the provincial universities may well be overdue, but this is not necessarily the only, or even the best, way to enable them to attract a larger proportion of the first-class minds in each generation of school-leavers The institution of a council for higher education to determine the allocation of funds for higher education is also recommended, but its position with regard to the University Grants Committee is somewhat ambiguous and no convincing evidence is presented that a new body is required rather than some re-arrangement or expansion of the functions of the latter Although it is recommended that each university should be encouraged to act as a teaching and research centre for the college of liberal arts and technology of its region, the question of technology is very superficially considered , and in seeking to break away from the conception of a university as a place providing specialized training for professional and highly scientific occupations towards one providing general education of a high standard, the signatories of the report seem to become somewhat confused and involved in contradictory policies

Much more fundamental thinking about the purpose and functions of a university is thus required to resolve the issues that are raised in this section of the paper The conception of the university as a place of learning and research as well as of teaching seems to have been overlooked, and while the recommendations on awards and grants are sound, the emphasis on the claims or rights of the individual, particularly in relation to admissions, seems to be excessive and to lose sight of obligations and responsibilities

A national university entrance examination, taken in March, from the results of which individual institutions would select their entrants without further test, is suggested Most of the group wish the Government to use financial pressure to reduce the proportion of entrants to Oxford and Cambridge from private schools , but the minority thought this was more likely to increase than to diminish the predominance of Oxford and Cambridge, and recommends rather that these Universities should no longer enjoy subsidies from public funds. The group recommends that all university students should pass through a diagnostic year of general education before being allocated to suitable courses. It does not discuss the practical implications of thereby extending university education to a fourth year, nor does the feasibility of this year of general education being given in the sixth forms of schools appear to have been considered. Again, it is taken for granted that wide adoption of the tutorial system in higher educational institutions and the consequent high staff–pupil ratio are justified. More experiment in teching methods would be welcomed, but the urgency of such an inquiry, as a preliminary or an essential part of university expansion, is nowhere emphasized; and although it is recognized that heavy teaching duties involve some easing of the demands of research and administration, the complexity of the issues raised thereby is dismissed too lightly. It is admitted that fresh thought is required on the subject of halls of residence, but the thinking of the group here appears to have been guided too much by its political preconceptions, and the part of the library is nowhere mentioned.

Nevertheless, in the section of the paper dealing with residence, there is some realistic thinking, though even here the group has its inhibitions, and its assertions that residence in hall prolongs adolescence and that such students are subsidized at the expense of other students could be challenged. The final section, however, with its emphatic recommendation that a comprehensive further education service should be established, is altogether admirable. Such a service should envisage the amalgamation of the youth employment and youth services, and the group suggests that the county colleges, for which provision was made in the 1944 Act, would constitute the natural headquarters, offering membership to every youth not otherwise enrolled in an institution of full-time further education. There would also be close links with the colleges of liberal arts and technology and with the extra-mural departments of the universities.

It is perhaps for this recognition that any sound policy must treat higher education as a whole and that its development must equally be planned in relation to secondary education and indeed primary education that the paper is most important. The paragraph in the Queen's speech dealing with education indeed referred to the schools as well as to technical colleges and universities, and at least implied that the supply of teachers is a common problem. A specific reference to the reduction in the size of classes might suggest that this is a priority in the Government's policy; but nothing was said in the debate on the Queen's speech to indicate that the independent investigations are already in train upon the results of which the priorities should be based. References to education in the House of Commons debate related mainly to the youth service and to the modernization of school buildings, and in replying on a debate which had been concerned mainly with the youth service, the Minister of Education, Sir David Eccles, conceded that in the last Parliament technical education had received the greatest attention. He said it is now time to give greater attention to the needs of the fifteen- to eighteen-year-olds, especially in leisure and in non-vocational education.

Sir David pointed out that this in itself brings us back to the primary schools and that we are concerned with the needs of some 7 million children and 300,000 teachers in all sorts of schools and colleges. The Government is fully determined, he said, to make a major advance in the youth services and the leisure activities of young people; but he gave no indication of either the magnitude of the effort or how the priorities are to be assessed.

Although education received rather less attention in the debate on the Queen's address in the House of Lords, the Earl of Home in a reply for the Government was a little more forthcoming. He welcomed Lord Rea's reference to our need to equip the young to meet the intellectual, physical and moral challenge of the time and, while admitting that the expansion contemplated for the universities and the technical colleges would strain our resources, agreed that it nevertheless must be made. Education, however, must look beyond technology, and Lord Home agreed with Lord Hastings on the need for constructive and imaginative thinking if the right solution to our problem is to be found. The mere expenditure of £700 million, a figure expected to rise for England and Scotland to £1,000 million a year by the early 1960's, is improbable of itself to suffice. We are unlikely ever to have the resources to do what is desirable at any one time. The selection of priorities is unavoidable, and what matters is that the right priorities should be chosen.

"A Policy for Higher Education" challenges the critical thinking and inquiry which should precede the choice of priorities and which should indicate the right priorities. Its main emphasis is on higher education, but not on higher education without regard to the needs of secondary education or of further education in the more general sense. The need for balance is recognized, and the discussion which it seeks to provoke should elucidate some of these issues and may even stimulate the impartial inquiry that is needed to collect the facts on which decisions should be based. Not least, apart from re-examination of the inter-relations between school and university, the paper should stimulate some fresh thought about the extra-mural work of the universities and their regional responsibilities.

MAGNETOHYDRODYNAMICS

Cosmic Electrodynamics

By Dr. J. W. Dungey. (Cambridge Monographs on Mechanics and Applied Mathematics.) Pp. ix+183. (Cambridge: At the University Press, 1958.) 32s. 6d. net.

A DECADE has elapsed since the publication of Alfvén's book, "Cosmical Electrodynamics"—a subject which was then beginning to attract the attention of the scientific world. Since then, the new science, now generally called 'magnetohydrodynamics', has grown in importance and interest and there exists to-day a vast literature on the subject—a fact which must be particularly gratifying to its originator The book under review, bearing almost the same title as Alfvén's book, gives some indication of the progress and of the consolidation which have been achieved in this field during the intervening decade , and while Alfvén inevitably confined himself for the most part to his own pioneer researches, Dungey has cast his net wider and, as was to be expected, his approach is more sophisticated

The book effectively consists of two parts, although the author makes no such division The first part deals with magnetomechanics proper, and some interesting causal general relationships are discussed at length Certain pitfalls which abound in this subject are pointed out—notably the fallacies into which one may be drawn by an injudicious application of the orbital motions of an isolated charged particle in a magnetic field to the behaviour of an ionized gas in a magnetic field

The second part of the book is concerned with applications to solar and terrestrial magnetism (mainly magnetic storms and aurorae), ionospheric electrodynamics and the author's own discharge theory of solar flares

There can be no doubt that the author has given an admirable synthesis of the subject The mutual interaction of the mechanical forces and the electromagnetic forces in a conducting fluid moving in a magnetic field is fully and clearly discussed, and attention is given to the important problem of the stability of twisted magnetic fields

One of the more important problems in that field, the stability of plasma equilibrium configurations, which has figured prominently in recent years in connexion with the problem of controlled thermonuclear reactions, is here discussed by the author mainly from the point of view of astrophysical applications Nevertheless, some attempt is made to discuss the problem more generally in the chapter on magnetodynamics under the section on small oscillations Brief references are also made to hydromagnetic shock waves and hydromagnetic turbulence

There is an admirable account of solar phenomena, including granulations, sunspots surface magnetic fields, prominences, flares and *M*-regions But the author seems to have been reluctant to supplement this by a more extensive account of current theories of sunspot magnetic fields , and the dynamo theory of the origin of the geomagnetic field is not treated as fully as one might have expected

The chapter on magnetic storms and aurorae, one of the most successful in the book, contains a fairly complete account of one of the current theories of these phenomena It is a pity that the author has not seen fit to make some reference to the theories developed by Alfvén and Singer, probably because Alfvén himself has given a full account of his theory in his own book Both theories contain many fruitful ideas, and the recently discovered Van Allen trapped-particle radiation appears to have been uncannily prophesied in Singer's work

There are few errors in this book , in the opinion of the reviewer it gives one of the most comprehensive and accurate accounts of magnetohydrodynamics yet published It is admirably constructed, and though it is not an easy book to read, the reader will nevertheless be amply rewarded by the many interesting and stimulating ideas he will find in it , it should be read by everyone interested in the subject

V C A Ferraro

DEVELOPMENT OF NUCLEAR POWER

The Economics of Nuclear Power, including Administration and Law

Vol 2 Edited by I R Maxwell, P W Mummery and Philip Sporn (Progress in Nuclear Energy, Series 8) Pp vi+419+xii (London and New York Pergamon Press, 1959) 105*s* net

Partnership for Progress International Technical Co-operation

Being the *Annals of the American Academy of Political and Social Science* (May 1959)

THE fifth annual report of the United Kingdom Atomic Energy Authority referred particularly to the need to relate plans for the development of reactors to the possibilities of the export market and pointed out that, although much of the Authority's work on the larger systems will have application to small reactors, considerable advances will be required in nuclear technology before reactors of the range 20–100 MW become competitive in normal circumstances It is in this context that a number of the papers contributed to the second International Conference on the Peaceful Uses of Atomic Energy which have now been published are of some general interest Some of those dealing with the economics of the generation of nuclear power, like those of J A Jukes on the economics of nuclear power, of J C Duckworth and C Hywel Jones on economic aspects of the United Kingdom nuclear power programme, have in a few points been modified by statements in Parliament or elsewhere

Three papers offer an important contribution to the discussions of power problems in the undeveloped countries Two of these are concerned with the world demand for nuclear energy in the first, K M Mayer reviews the economic setting for nuclear power and heat development, and in the second, Dr H J Bhabha discusses the need for atomic energy in the under-developed countries With N B Prasad he also surveys the contribution of atomic energy to a power programme in India Besides these, the Atomic Energy Commission of Japan describes the long-term plan for the development of atomic power reactors in Japan authorized in 1957

This plan emphasizes the large number of scientists and engineers required for technical research on and the manufacture of reactors, fuel elements and related equipment, and recognizes that there is a scarcity of such men throughout the world With this difficulty Dr Bhabha does not appear to be concerned, and to him the problem is one rather of economics and capital investment It is probable, however, that the question of scientific and technical man-power, and the related one also recognized by the Atomic Energy Commission of Japan of a national industrial structure which permits efficient and easy assimilation of nuclear reactors and equipment, are far more important than finance It is at least clear that the effective exchange of information and scientists and the establishment of close international co-operation, of which the Geneva Conference and the publication of its edited proceedings is an outstanding example, are essential factors in all such developments

The development of nuclear power more especiall in the under-developed or less advanced indus countries is, however, only a particular exa international technical co-operation, an

1959 issue of the *Annals of the American Academy of Political and Social Science* devoted to that theme should be of even wider interest It shows the perspective in which technical co-operation is seen by Americans whether from the Congress end or from within a particular mission The characteristic approaches of the United Nations Expended Programme and of the United States Point Four Programme are next outlined and then the less well-known bilateral approach of the Sino-Soviet Bloc technical assistance

The bulk of the Symposium, however, is concerned with problems of administration, and these are illustrated finally by descriptions of three programmes the United Nations programme in Brazil , the United States operations mission in Iraq , and the Ford Foundation programme in Pakistan The problem of finance is not ignored and Dr L K Caldwell deals imaginatively with the role of the technical expert, as does Mr R W Jones with the problem of personnel management in this field Constructive suggestions are to be found in the papers by P M Glick on the choice of instruments for technical co-operation, by H Reining on the Government contract as an administrative device, and by G W Lawson on technical co-operation for administrative improvement By and large the papers cover from an American angle ground already traversed by Political and Economic Planning, and while they do not offer much in the way of new proposals they show the extent to which there is common ground in much progressive thought in this field, some directions in which further study and creative thought are needed and the magnitude of the effort which is already being made, to which in a special field some of those papers contributed at the Geneva Conference on the Peaceful Uses of Atomic Energy also testify

R BRIGHTMAN

ROCHESTER CONFERENCE ON SEMICONDUCTORS

Advances in Semi-Conductor Science

Proceedings of the Third International Conference on Semi-Conductors, held at the University of Rochester, U S A , August 18–22, 1958 Edited by H Brooks (International Series of Monographs on Semiconductors) Pp ix+553 (London and New York Pergamon Press, 1959) 100*s* net

THE report of a conference can unfortunately be little more than a collection of papers which could have appeared several months earlier, distributed among a handful of journals, and can be devoid of any of the spontaneous interchange of ideas which a conference should promote That of the Rochester conference on semiconductors does, however, include summaries of the discussions concluding each session, a review by J Bardeen of the trends in semiconductor research emphasized by the conference, and five excellent descriptive summaries by H Brooks, D Polder, L Apker, W H Brattain and C Herring Although the conference was nominally as international as those previously held at Reading, Amsterdam and Garmisch-Partenkirchen on the same subject, it was in fact dominated by American contributions and participation , but the importance which has long been attached to the subject by American defence departments, industry and universities assured an excellent array of papers, even though none seems destined to alter profoundly the course of the subject

The exciton was given much attention Broser, who had, two years previously, invoked exciton diffusion to account for the propagation of photoconductivity in some semiconductors, now considered that photon emission, scattering and reabsorption better explained the findings of further experiments His earlier co-worker, Balkanski, on the other hand, did not reject the idea that excitons could have large diffusion lengths Much interest was aroused by reports on clean surfaces of semiconductors (freshly cleaved or cleaned by bombardment), which require vacua of the highest order for their examination At the same time, the practical importance of real surfaces was reflected in the continued efforts to find a model which explains the dependence of the surface electrical properties on the bulk properties, preparation and environment Compound semiconductors, though not ignored, did not play a leading part , further physical investigations of some probably await a tenfold reduction in the content of the residual impurities Hot carriers figured prominently in a session on transport phenomena, but the avalanche effect and tunnelling, which has more recently opened up a new field of application of degenerate semiconductors, were not mentioned

If the report lacks a few outstanding papers, it none the less shows that further conferences can be held on this subject , the scope may have to be limited, however, if both the conferences and their reports are not to be unwieldy J R TILLMAN

ENGINEERING STATICS

Elements of Engineering Statics

By Prof H Deresiewicz Pp vi+124 (New York Columbia University Press , London Oxford University Press, 1958) 28*s* net

STATICS has gained importance in engineering science because, together with the geometry of deformation, it forms the basis of structural analysis generally However, owing to the apparent requirements of engineering practice over the past 100 years, a variety of set procedures for the analysis of structures has been developed, using the principles of statics and geometry and the assumption of elastic behaviour Accordingly, text-books on theory of structures have tended to be concerned more with the details of these procedures, or so-called methods of analysis, than with general principles This has led to some confusion and misapplication of principles as well as failure to adopt a rational and discriminating approach to structural analysis Thus, even in published work, the so-called principle of least work, due to Castigliano (1873), has been regarded as an application of the statical principle of minimum potential energy While the former is concerned with the compatibility of deformations within statically indeterminate structures the elasticity of which is linear, the latter is concerned with the stable equilibrium of conservative statical systems generally

Having regard to this background, a book of the kind written by Prof Deresiewicz, which presents the principles of statics in relation to the requirements of engineering science, is welcome indeed It contains chapters on the elements of vector algebra, equilibrium including consideration of statical determimacy, equivalence of force systems, simple structures, sliding friction, work and energy methods and equilibrium of space systems Chapter 7, on work and energy methods, is particularly important as an introduction to energy principles and their power as analytical devices, and should serve to prevent the kind of confusion to which reference is made above Thus, sections on real and virtual work, potential energy and stability are included in this chapter

Another important feature of the book is the large number of worked examples which it contains and the appended selection of examples for solution, with answers It is to be hoped that this book attracts the attention of teachers and students and that, together with similar works in the future, it will lead to more advanced courses in applied statics to supplement those in techniques of structural analysis

T M Charlton

GRASSLAND MANAGEMENT

Grass Productivity

By André Voisin Translated from the French by Catherine T M Herriot Conversion of Tables by M M Sandilands Pp xiv+353+41 photographs (London Crosby Lockwood and Son, Ltd , 1959) 50s net

This book by André Voisin is timely if only for the influence it may have in re-stressing the importance of exploiting pasture by better grassland management practices M Voisin is a scientist who became a practical farmer , he farms a sixty-acre dairy farm wholly in grass in the Department of Seine Inférieure near Dieppe He has clearly given much thought to the problems of growing grass and of using it intensively by means of his dairy herd He is an enthusiast particularly in respect of the health of his animals and as a farmer is much concerned with high yields, attaining thereby a satisfactory economic return He regards the process of grazing as the "meeting of cow and grass" and throughout his book indicates the importance of this concept by laying emphasis on the facts that the yield from grazed pasture enormously depends upon the way animals are put to graze it, and also on when they graze in relation to the physiological growth of the herbage offered them

High quality and maximum yields from pasture lands in France, as in Britain, come about as a result of good farming practices and one feature of these is the part which animals play in maintaining the botanical balance between species in the pasture It is by no means certain, however, that the animal is an essential ingredient of the 'high-production pasture complex' Indeed, many pasture fields in Alpine Europe are highly productive by any modern standard and yet are seldom grazed by animals The recent interest in so-called 'zero grazing' and the nineteenth century vogue for 'soiling' in Britain involve periodic harvests of herbage and feeding it immediately to animals living away from the field on which it is grown The success of all these schemes depends upon maintaining rapid growth and high levels of herbage yields by fertilizer (including dung and urine) applications to the pasture fields Given these conditions there need be no difficulty in maintaining either immediate yield or balance of botanical constituents upon which continued productivity depends Success as a viable economic process depends much also upon the input of labour and machinery in relation to net output of animal product, compared with other systems of utilization

M Voisin attempts to describe in some detail the mechanism of grazing and perhaps draws too large a distinction between normal grazing by the cow and harvesting by machine Undoubtedly there are differences between these two mechanisms, but it is dangerous to over-stress the differences out of context It may be that the mechanics *per se* of grazing are no more important than is the fact that animals deposit dung and urine on the land from which they graze, and thereby return plant nutrients into circulation and so accelerate the rate of turnover of nutrients within the plant/animal/soil system M Voisin makes much of the concept that "cows refuse to work any hours of overtime" The suggestion that grazing animals feed when at pasture for strictly eight hours a day is based on quite fragmentary evidence In fact there are a number of records in the literature which show that in many circumstances the ruminant will actively graze for many more hours a day than the stipulated 'union rate' of eight hours

The book is excellently produced and the English translation done well, although a number of errors occur in the text Some of these are almost certainly due to translation and can be eliminated in a second edition There is also a good deal of repetition which is possibly more obvious in the English text than in the original M Voisin's book, however, should prove a useful addition to the library of any thinking husbandryman

W Davies

HUMANE EXPERIMENTS

The Principles of Humane Experimental Technique

By Dr W M S Russell and R. L Burch Pp xiv+238 (London . Methuen and Co , Ltd , 1959) 30s net

Experiments on living animals present a number of difficulties Individual animals differ from one another in their responses, so it is usual to make numerous replicate observations as a basis for reliable predictions Animals are sensitive to small changes of many kinds in their environment, and this sensitivity can affect an animal so that it reacts differently to the same experimental stimulus on different occasions The more disrupting the stimulation, the more violent the reactions of the animal and the more inconsistent its response These are also the circumstances in which the animal is in all probability distressed or in pain The various responses which are associated with distress and pain, and which help the animal to overcome or escape from injury greatly complicate any study of the direct response to the initial stimulation, and so are usually undesirable from the scientific as well as the humane aspect Every step which can be taken to reduce the complexity of an animal's response will reduce also the experimental variation, and so there is good reason for considering humanity and experimental design as one problem

It is both humane and economical also to use as few animals as possible in experiments However, it is rather difficult to know to what extent Britain the use of animals is minimized The f available from the Home Office returns detailed enough to be informative More extensive information was obtained in a survey conducted by the Laboratory Animals Bureau in 1952 This survey depended on the voluntary co-operation of the relevant laboratories, but as about 80 per cent replied, the results are reasonably representative The material has already been analysed by Lane-Petter with particular reference to the procurement of experimental animals, and it is now analysed again in this book by Russell and Burch from the point of view of their use

It must be admitted that it is a rather incoherent body of data and its defects are indicated (as Dr Russell admits) when 108 canaries of Lane-Petter's report reappear in the present analysis as 72 ducks However, it is the best available, and its inadequacy suggests that the best and most economical use of animal resources does not receive as much attention as it deserves The rest of the book deals with this problem in terms of replacement of the whole animal by a physical or chemical system, a tissue culture, or a preparation of an isolated organ , reduction of the numbers needed by avoiding quantal observations and other extravagant designs and by good environmental control, and refinement of technique in choosing suitable species, responses and methods of approaching a problem

All these approaches are desirable and useful, but must be considered in the light of the particular problem which it is necessary to solve experimentally It is useful to have a résumé of ways which have already been adopted to make experimentation as humane as possible, and so this book is in some ways supplementary to the well-known UFAW handbook on the care of laboratory animals It is not sufficiently informative to be used as a guide either to details of experimental design or to the husbandry of experimental animals Perhaps its chief purpose is to stimulate thought on both these topics, and it is to be hoped that it will succeed in doing so

M Weatherall

U.S. ARMY NEUROSURGERY IN THE SECOND WORLD WAR

Surgery in World War II Neurosurgery, Vol I
Colonel John Boyd Coates, Jr , M C , Editor in Chief (Medical Department, United States Army) Prepared and published under the direction of Major General S B Hays Pp xix+466 (Washington, D C Government Printing Office, 1958) 5 dollars

A HISTORY of surgery in the Second World War is in course of preparation by the Medical Department of the United States Army Two volumes are devoted to neurosurgery The first of these has been published and deals with the organization of the neurosurgical services and the care of head injuries at all stages after wounding The second volume will deal with spinal and peripheral nerve injuries

The first volume is edited by Drs R G Spurling and Barnes Woodhall, contains 466 pages, and is beautifully produced and illustrated Although fourteen authors have contributed sections, there is little overlap between these, and the quality of almost every section is extremely high The early chapters are concerned with the planning and development of neurosurgical services in the United States itself, and the European and Mediterranean theatres, and reveal what can be achieved by excellent organization Thus the nine neurosurgical centres set up in the United States in August 1942, each with 150 beds, had increased in two years to nineteen, each with 350–500 beds, and within another year certain of these hospitals had 2,000 beds Although a programme of training for military neurosurgeons was instituted early in the War, it is no surprise to hear that it was at times difficult to find what was considered to be the appropriate medical personnel for these numerous centres, in particular at the ward officer level When the demand for neurosurgeons overseas developed, the problem of distribution of personnel was at times difficult The assistance of organic neurologists would have been invaluable but their scarcity in comparison with neuropsychiatrists rendered such aid quite infrequent The contributions of the consultant neurosurgeons in disseminating knowledge through visits, news-letters and conferences were invaluable In all theatres of operations it was believed that neurosurgeons could be most profitably employed in evacuation hospitals 15–20 miles from the front, the patients being transferred to neurosurgical centres some days later

The greater part of the volume is given over to the consideration of therapy in the head injuries of modern warfare, and contains several outstanding contributions In one of these the modern management of missile wounds of the head receives detailed consideration. The post-operative fatality rate in several groups of patients treated by such techniques was approximately 14 per cent, another 12 per cent of the patients reaching hospital after a head injury dying without treatment These figures give eloquent testimony to the success of the plans for treating neurosurgical casualties and the skill of those who carried them out

Another excellent contribution deals with post-traumatic epilepsy Almost 250 patients were submitted to a carefully planned study In 55 per cent, seizures were controlled medically for a minimum period of four months , 17 per cent were lost to the investigation and in 28 per cent the attacks remained uncontrolled Two-thirds of the latter group of 66 patients were treated surgically From the early results it is considered that surgical measures may have a limited place in the management of post-traumatic epilepsy which does not respond to medical measures

Other articles deal with pathological aspects of missile wounds, blast concussion, infective complications of brain wounds and ventricular penetration by missiles, as well as the repair of skull defects Perhaps the only omission is a discussion of the rehabilitation and resettlement of patients with brain wounds Such a section would have completed the story of the group of patients so fully considered from other points of view

This contribution to the history of surgery in the United States Army in the Second World War is a very valuable one It is a fascinating account of the development of the Army neurosurgical services and their utilization during the greatest of wars Moreover, it provides in readily available form detailed information which will be invaluable to those concerned in the development of a military neurosurgical service in the future, should the need for this arise

J E A O'Connell

Précis de Pétrographie

Roches Sédimentaires, Métamorphiques et Éruptives Par Prof Jean Jung Pp 314+20 planches (Paris Masson et Cie, 1958) Broché, 3,600 francs , Cartonné toile, 4,600 francs

TO Prof Jung, petrography and petrology are ill-separated, and in this book he considers not only the descriptions of different sorts of rocks in thin section but also their mutual relations and origins The book is intended as an introduction to the science of rocks for students engaged on degree courses, and it is an admirable introduction, concise and essentially complete There are, however, no references or bibliographies, which may be considered a drawback in a work which is so condensed It is organized in four sections, the first on rock-forming minerals, the second on sedimentary and residual rocks, the third on metamorphic rocks, and the fourth on igneous rocks, each of which is copiously illustrated with excellent line drawings and photographs

An early chapter contains one of the most compact, readable, logical, and memorable expositions of the structure of the silicates to be found in any text-book, and sets the tone for the rest of the book The clarity of the writing is such that very modest linguistic ability, aided by a good dictionary, is sufficient to make the text easily intelligible Even so, it is probable that the majority of English-speaking students will not wish to add translation to the other burdens involved in mastering a new subject, and possibly the greatest value of the "Précis de Pétrographie" outside the French-speaking world will be to more advanced students, who will find in it a rapid means of verifying the systems of rock nomenclature and classification in use in France, together with the accepted views on petrology current there

J C. M Taylor

The Physics of Elementary Particles

By Prof J D Jackson (Investigations in Physics, No 9) Pp x+135 (Princeton, N J Princeton University Press , London Oxford University Press, 1958) 30*s* net

THIS book gives a simple and readable account of the main features of elementary particles and their interactions other than the electrodynamic interaction of photons with electrons and positrons

The first part of the book deals with pi-mesons and nucleons, particularly pion-nucleon scattering and photo-pion production These processes are treated from a semi-classical point of view, but an outline is also given of the dispersion relation approach to scattering The determination of the spin and parity of the pions is not discussed, which is a pity, as a few extra pages would have added greatly to the completeness of the picture

The next section gives the basic facts about *k*-mesons and hyperons, introduces the concept of 'strangeness' and distinguishes clearly between strong and weak interactions

The last part of the book describes the weak interactions, including a discussion of space and time reflexion, and charge conjugation invariance The final sections review the experimental determination of the β-decay interaction and discuss the universal Fermi interaction

In his preface the author wisely remarks "In a field of physics that is changing every instant it is senseless to hope that a book written to-day will endure beyond to-morrow, but I hope that this volume will serve for a short time as a useful introduction to a fascinating subject" He has succeeded admirably in this limited objective

P T Matthews

Analytical Chemistry

Some New Techniques By A G Jones. Pp viii+268 (London Butterworths Scientific Publications , New York Academic Press, Inc , 1959) 40*s*

IN this useful book, several of the more recent techniques of analytical chemistry are described Larger texts, mainly American, have appeared which cover similar ground, but these have generally been designed for advanced student training The book under review is aimed at senior chemists who have little time to delve into the original literature and who want a succinct account of a new technique

The methods which have been chosen are flame photometry, differential spectrophotometry, gas chromatography, ion exchangers, acid-base titrations in non-aqueous media, coulometric titrations, differential refractometry and the determination of oxygen and hydrogen in metals In each section, the principles of the method are delineated, the essential apparatus is described and the applications are discussed A broad idea of the possibilities of each technique is given and, just as important, its limitations are mentioned , the reader is warned of the most likely sources of error A number of references is given to more detailed texts and to the original literature

The section on the determination of oxygen and hydrogen in metals is devoted to the analysis of the one-time rarer metals , most of the actual techniques in this part have been used for years in the iron and steel industry, but their broader application is quite recent and has involved special problems

In general, this little book serves its purpose admirably and should be welcomed as a simple exposition of several very valuable techniques

A M G Macdonald

Mites, or the Acari

By T E Hughes Pp vii+225 (London The Athlone Press, University of London, 1959 Distributed by Constable and Co., Ltd) 42*s* net

IT is surprising in view of the economic importance of mites and ticks that this should be the first comprehensive account of their biology and anatomy to be published in Britain Mr Hughes's text can be considered in two sections In Chapters 1–6 an account is given of the biology of both free-living and parasitic species, while Chapters 7–14 deal with their anatomy The formidable task of gathering biological information from a scattered literature and presenting a readable survey has been well done, although it is unfortunate that a number of errors have escaped the author's notice For example, it is incorrectly implied that the Bdellidae are exclusively littoral and that the Rhodacaridae prefer saturated conditions The second section is more authoritative The discussion of the external and internal anatomy of the Acari is based on a critical review of evidence, a considerable amount of which has been derived from the author's own researches. The outline classification presented in the final chapter should prove useful to the general zoologist The book is well produced and the text-figures are of high standard throughout

G O Evans

GAMMA-RADIATION FROM DEPOSITED FALL-OUT

By D. H. PEIRSON and L SALMON

Health Physics Division, Atomic Energy Research Establishment, Harwell

THE rate of deposition of fission products from nuclear test explosions has increased since 1957 This increase is shown, for example, in the annual deposition of strontium-90 observed[1,2] in rainfall at Milford Haven, Pembrokeshire

Table 1

Year	Deposition of strontium-90 (mc /km ^{2})
1952–54	2 0
1955	2 4
1956	2 5
1957	2 6
1958	5 4

About two-thirds of the deposition in the United Kingdom during 1959 is produced by the explosions of autumn 1958 This is deduced from measurements of the strontium-89/90 ratio in rainwater and similar data from dust samples from the atmosphere Therefore, not only has the rate of fall-out increased but it also follows that current deposition contains a large proportion of fission products of half-lives shorter than those of strontium-90 (28 years) and cæsium-137 (30 years), which are considered to have the greatest long-term radiological significance It is instructive to consider the increase of external gamma-radiation due to the deposition of the short-lived fission products

Analysis of Soil

The increase in gamma-radiation has been analysed by assaying samples of soil and grass from several sites in the United Kingdom

Samples of undisturbed topsoil, including vegetation and root-mat, are cut in dimensions 15 cm × 15 cm × 7 cm deep Each sample is thoroughly mixed and counted in bulk ($\sim$ 1 kgm) by a gamma-ray scintillation spectrometer, containing a sodium iodide crystal (7 5 cm × 7 5 cm diameter) shielded by 10 cm of lead and coupled to a multi-channel pulse analyser The gamma-ray spectrum of the deposited fission products lies superimposed upon that of the natural radioactivity of the soil, namely, the uranium and thorium series and potassium The spectrum of natural radioactivity is measured at each site in a second sample cut from immediately beneath the first Comparison of the spectra from the two samples allows the contribution due to fission products to be extracted from the composite picture, since in all cases it is found that at least 95 per cent of the deposited fall-out is confined to the top 7 cm of soil

The principal fission products that have been assayed by this means in recent soil samples are shown in Table 2

Parent and daughter activities are bracketed in this table Half-lives and gamma-ray energies are available from Strominger *et al* [3]

Table 2

Fission product	Gama-ray energy (MeV)	Half-life
Cæsium-137	—	30 year
(Barium-137*m*)	0 661	2 6 min
Zirconium-95	0 72, 0 76	65 day
Niobium-95	0 77	35 day
Ruthenium-103	0 50	42 day
Ruthenium-106	—	1 year
Rhodium-106	0 51	30 sec
Cerium-141	0 145	33 day
Cerium-144	0 134	290 day

The results of soil assays at seven sites are summarized in Table 3

Apart from the case of cæsium-137 the significant gamma-ray activities in the soil samples arise from combinations of pairs of fission products The genetic relationship between zirconium-95 and niobium-95 permits calculation of the contribution from each, assuming the pair to be in transient equilibrium No such relationship exists in the other pairs, so to avoid the uncertain conversion to beta-disintegrations, the surface concentrations of deposited fission products are expressed as mc /km ^{2} of the appropriate gamma-disintegrations An additional component observed in the spectra of most samples, but not listed in the table, has been attributed to zinc-65 (245 days) The contribution of this isotope to the total activity is insignificant

Continuing deposition will increase and radioactive decay will decrease the content of any radionuclide Since collection of the soil samples was extended over a period of three months, the activity of the short-lived gamma-ray emitters at the various sites should be compared in the light of these factors The small contributions from cerium-141, -144, ruthenium-103 and rhodium-106 are a result of low yield per fission, low gamma-ray abundance per disintegration or previous decay The activity of cæsium-137 represents an accumulation from explosions over some years, whereas that of zirconium-95–niobium-95 originates from the most recent series of tests

Soil samples from Illinois in 1957 were analysed in a similar manner by Gustafson *et al* [4]

Cumulative Deposition in Rain

The relationship between the surface concentration of cæsium-137 and mean annual rainfall is demonstrated in Fig 1

The concentrations of activity due to cæsium-137 and zirconium-95–niobium-95 at Milford Haven may be derived in another way by calculating the cumulative deposition, corrected for decay, in rainwater These are plotted in Fig 2 The activity of cæsium-137 was obtained from published deposition data[1,2] Measurement of the deposition at Milford Haven of zirconium-95–niobium-95 (unpublished) started only in August 1957 An approximate

Table 3

Site and date	Cerium-141, -144		Ruthenium 103, Rhodium-106		Cæsium-137		Zirconium-95–Niobium-95		Total
	mc γ/km ^{2}	μr /hr	mc γ/km ^{2}	μr /hr	mc γ/km ^{2}	μr /hr	mc γ/km ^{2}	μr /hr	μr /hr
Kew (Surrey) 26 8 59			8	0 07	13	0 15	34	0 44	0 7
Chilton (Berks) 3 6 59			34	0 30	22	0 25	158	2 05	2 6
Abingdon (Berks) 25 6 59	24	0 05	22	0 20	28	0 32	135	1 77	2 3
Milford Haven (Pembroke) 14 7 59	17	0 04	18	0 16	43	0 50	182	2 37	3 1
Eskdalemuir (Dumfries) 28 8 59	19	0 04	27	0 24	54	0 62	130	1 00	1 9
Windermere (Westmorland) 10 7 59	24	0 05	33	0 30	75	0 86	331	4 30	5 5
Snowdon (Caernarvon) 27 6 59	40	0 09	57	0 51	133	1 53	567	7 38	9 5

starting point for this curve was obtained by the somewhat crude assumption that the cumulative deposition of zirconium-95 at this date was identical with that of strontium-89 (available from ref 1) Any error due to this assumption becomes progressively less important after September 1957 on account of the radioactive decay Thus by March 1958 the initial error has been reduced to one-tenth

The calculation from cumulative deposition gives estimates of the concentrations of activity of cæsium-137 and zirconium-95 and niobium-95 at Milford Haven that are about 70 per cent of those from the soil assay The factors that might contribute to this discrepancy include non-uniformity of the site drainage, inadequacy of the sampling method and the possibility of dry deposition The analytical error, at least for the determination of cæsium-137 and zirconium-95–niobium-95, is probably not greater than 10 per cent

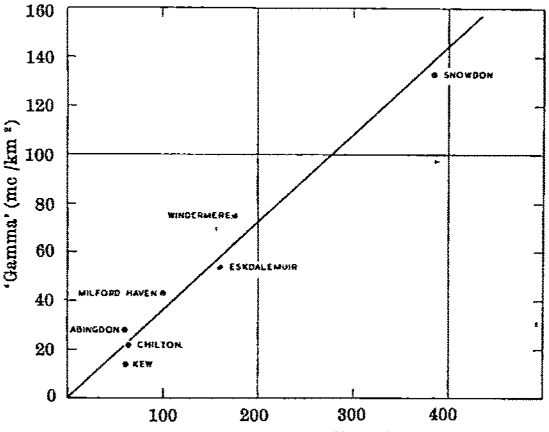

Fig 1 Cæsium-137 in soil (June–August 1959) versus rainfall

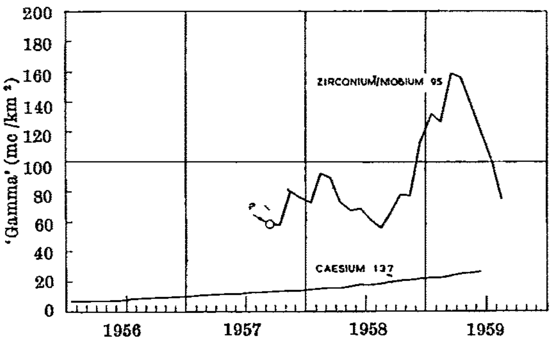

Fig 2 Cumulative deposition at Milford Haven

Gamma Radiation Dose-rate

The surface concentrations listed in Table 3 are converted to gamma-ray dose-rates by using the data of Chamberlain[5] The dose-rates at a height of 1 metre are calculated by neglecting absorption in the soil The effect of absorption is small for the freshly deposited zirconium-95–niobium-95 but may be significant for the long-lived cæsium-137 that is subject to continuous weathering

Only at the Chilton site is it possible to compare by direct measurement the gamma-radiation dose-rates due to fission product and natural radioactivity Elsewhere no measurements were made before the period of significant fall-out At Chilton the dose-rate due to natural radioactivity (excluding cosmic rays) is 5 μr /hr The increase in June 1959 due to fission product deposition is $\sim$ 50 per cent

It is clear that, during this period of soil sampling, the enhancement of gamma-radiation dose was mainly due to the fission products zirconium-95–niobium-95 Undoubtedly, if nuclear test explosions were not resumed these short-lived fission products would become insignificant compared with cæsium-137 If the production of nuclear debris continues at the rate of 1957–58 then the gamma-radiation dose from zirconium-95–niobium-95 could become a significant radiobiological hazard Thus at mean rates at Chilton corresponding to June 1959, the approximate annual dose above uncultivated land from zirconium-95–niobium-95 would be 20 mr /year and that for cæsium-137 2 mr /year, compared with about 40 mr /year from 'natural background' activity (excluding cosmic rays) At other sites having heavier rainfall and greater fall-out deposition the annual dose-rates would be correspondingly larger

The dose to the population, making allowance for weathering and shielding by buildings, has been estimated by Spiers (see following article)

[1] Stewart, N G , Osmond, R G D , Crooks, R N , and Fisher, Miss E M R , A E R E Report *HP/R* 2354 (H M Stationery Office, 1958) Stewart, N G , Osmond, R G D , Crooks, R N , Fisher, Miss E M R , and Owers, M J , A E R E Report *HP/R* 2790 (H M Stationery Office, 1959)

[2] Crooks, R N , Osmond, R G D , Owers, M J , and Fisher, Miss E M R , A E R E Report *R* 3094 (H M Stationery Office, 1959)

[3] Strominger, D , Hollander, J M , and Seaborg, G T , *Rev Mod Phys* , **30**, 585 (1958)

[4] Gustafson, P F , Marinelli, L D , and Brar, S S , *Science*, **127**, 1240 (1958)

[5] Chamberlain, A C , A E R E Report *HP/R* 2606 (H M Stationery Office, 1958)

SOME MEASUREMENTS OF BACKGROUND GAMMA RADIATION IN LEEDS DURING 1955–59

By Prof F W SPIERS

Department of Medical Physics, and M R C Environmental Radiation Research Group,
University of Leeds

GREAT interest centres on the extent to which the fission products from nuclear weapon tests add to the dose received by human beings from natural environmental sources The extra radiation dose is contributed both by radioactive nuclides which become incorporated in the body and by penetrating radiations from fission products deposited on the ground Estimates of the external fraction of the dose[1,2] suggest that it is smaller than that received from internal sources, but such calculations necessarily involve many assumptions , The radiation dose out-of-doors is calculated for a uniformly contaminated plane surface and assumptions are made concerning the leaching away of surface deposition by rain. In estimating the dose to the population further assumptions must be made as to the shielding afforded by houses and the fraction of the day spent out-of-doors

A number of measurements of the total γ-ray dose-rate have been made in Leeds over the years 1955–59, and these, together with other observations now reported, indicate that over undisturbed grassland a considerable increase in dose-rate has occurred Present information is insufficient to determine an over-all average increment for sitesi ndoors and out-of-doors but the increase will be much less than that over grassland , tentative estimates, however, suggest that it is probably greater than the dose-rate to body tissues from ingested cæsium-137[2]

Measured γ-ray dose-rates at points 1 ft above the centres of two small lawns in Leeds are shown in Fig 1 They have been made at varying intervals since July 1955, the first four measurements being made with Geiger counters and those since August 1, 1957, with a portable high-pressure ionization chamber The two Geiger counter measurements *C* and *D* in 1957 were standardized by comparison with the calibrated high-pressure ionization chamber , the measurements in 1955 (*A*) and 1956 (*B*), made with different counters, were each linked to those in 1957 by the γ-ray responses to a standard radium source

The high-pressure ionization chamber was used in these investigations because its sensitivity and stability of response enable the level of background gamma-radiation to be followed over a long period of time The chamber was used under drift-rate conditions and the change of potential of the central electrode was measured by applying a balancing voltage to the grid of a miniature electrometer valve in a Townsend balancing circuit Calibration was carried out in a large hall, under conditions of minimum practicable scatter, with sources of radium and iodine-131 giving known gamma-ray dose-rates[3] The final calibration figure was derived on the basis that the local gamma-radiation could be regarded as approximately equivalent in quality to a mixed radiation, in which 70 per cent of the dose-rate was attributable to radium gamma-rays and 30 per cent to iodine-131 gamma-rays[4] A drift-rate of 1 volt per min on the central electrode then corresponded to a γ-ray dose-rate of 50 3 m rad per year or 5 73 μrad per hour The stability of response of the instrument is shown in Fig 1 by the measurements made inside a heavily shielded steel cubicle where the radiation, being almost entirely cosmic, is independent of changes in the local gamma-radiation outside it The measured response in the steel room has remained throughout at 0 50 ± 0 01 volt per min when corrected for the small changes of cosmic-ray intensity with barometric pressure Corresponding to this response within the steel shield, a drift-rate of 0 7 V per min has been subtracted from the outside readings to allow for the cosmic-ray contribution

The local γ-ray dose-rate over lawn 1 (Fig 1) shows a small rise during 1955–57, but, in addition to fluctuations which include the transient effect of the Windscale reactor accident[3], there is a marked increase from the autumn of 1957 to May 1959 There are fewer observations on lawn 2, but they show a very similar rise The dotted curve in Fig 1 gives the total deposition of strontium-90 at Milford Haven[5], which provides some indication of the total deposition of long-lived fission products The surface gamma-radiation cannot be expected to follow this closely, but the increase in slope of the γ-ray curve is roughly in step with the increased deposition of strontium-90 since the beginning of 1958

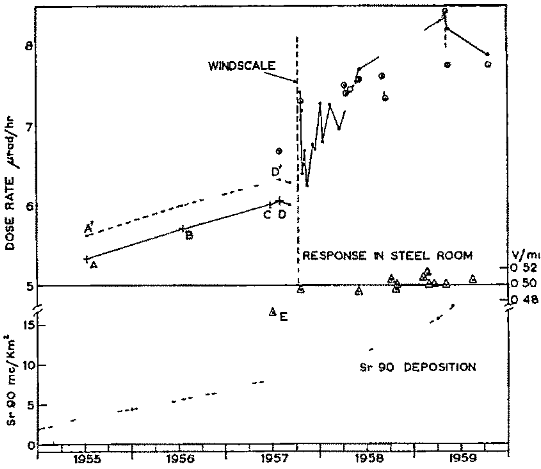

Fig 1 γ-Ray dose-rates over lawns in Leeds , the line *A' D'* indicates the revised dose-rates for *A*, *B*, *C* and *D*, if the whole of the difference between point *E* (a single observation) and the other measurements in the steel room were attributable to grid current in the electrometer valve

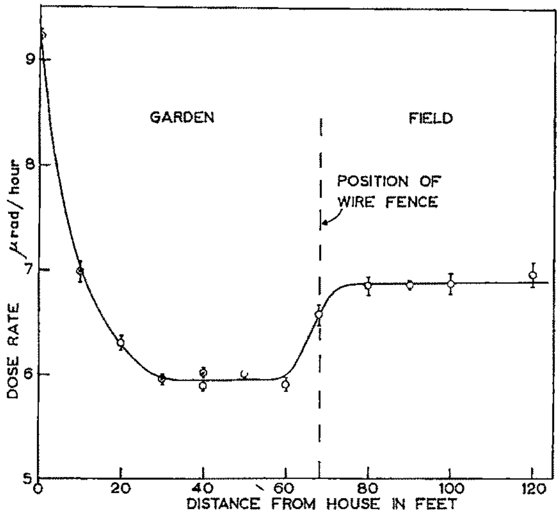

Fig 2. Dose-rates over tilled soil and permanent grassland near Leeds, June 1959 (Tilled soil was 'rotovated' in December 1958, March and May 1959)

The most recent observations recorded in Fig. 1 (October 1959) show some decrease from the high values reached in May, in accord with the decay of the deposited zirconium-95–niobium-95 fission products which contribute a large fraction of the gamma radiation. The dose-rate over lawn 1 in May 1959 was about 3 μrad per hr., or 25 m rad per annum, greater than in 1956. This measured increase can be compared with the dose-rates of 2.3–3.1 μrad per hr., calculated by Peirson and Salmon (see preceding article) from the measured amounts of fission products in the top 7 cm. of soil for sites at Chilton, Abingdon and Milford Haven. The increase in dose-rate measured at Leeds is about one-half that calculated for Windermere and one-third of that for Snowdon (Peirson and Salmon). Increments in the γ-ray dose-rate of 2.2, 1.2 and 3.1 μrad per hr. have been calculated by Gustafson[6] for the months of April, July and September 1958, respectively, on the basis of the measured fission product activity in soil at Argonne National Laboratory.

An observed difference in the γ-ray dose-rate over tilled land and permanent pasture is shown in Fig. 2. The dose-rate of 9.2 μrad per hr. near the house wall includes the contribution from the radioactivity of the brickwork, but at 40 ft. from the house the dose-rate at a height of 1 ft. is evidently representative of the activity of the surrounding land. The dose-rate over the uncut pasture is about 1 μrad per hr. greater than that over the garden, a difference which may be reasonably ascribed to burial of the fission products by mixing them to a depth of 6 in. to 9 in. by 'rotovation'. One month later, after the grass had been cut and removed, the difference between the field and the garden had fallen to about 0.5 μrad per hr. and 5 months later the dose-rates at the two sites were the same, within the error of measurement. Incidentally, at the time the hay was stacked the dose-rate near the haystack was 4 μrad per hr. above that in the open field.

The finding that radioactive deposition is located in the upper layers of undisturbed soil (Peirson and Salmon as ref. 6) is supported by some observations of the γ-ray dose-rate over a small lawn deliberately contaminated with iodine-131 at a level of 40 μc. per sq. m. This contamination produced an initial dose-rate (at 1 ft. above the lawn) of 105 μrad per hr., or about ten times the background-rate, on March 17, 1958, and the dose-rates, measured periodically over the next 45 days, are shown in Fig. 3. It was hoped that the rainfall of an English spring might provide evidence of the leaching effect of the iodine-131 from the soil. The rainfall was rather small, however, and the test fell short of its original design. It is evident from Fig. 3 that the dose-rate diminished at a rate almost equal to the iodine-131 decay rate and that the rainfalls of 1.2 in. for April and 0.7 in. for May did not appreciably affect the dose-rate by carrying the contamination to any considerable depth.

Although it is not possible to assess accurately the effect of fall-out on the external dose-rate to the population, it is useful to consider what increase in average dose-rate might be implied by the present observations on the Leeds lawns. With regard to weathering, the evidence on the deposition of fission products in the surface layers of undisturbed soil suggests that the dose-rates observed over lawns are not very much less than those to be expected if the fall-out remained without loss on the surface. An indication of the attenuation which might result from absorption of radiation, when the fall-out is distributed throughout the top 3 in. of soil, is given by observations of reduced dose-rate over snow. On two occasions in 1958, layers of snow about 4 in. deep reduced the observed dose-rates on lawn 1 to about 85 per cent of the 'unshielded' values obtained immediately after the snow melted. About the same degree of attenuation might reasonably be expected for the radiation from fission products lying at a mean depth of 1–1.5 in. The observed increase of about 25 m rad per annum in the dose-rate over lawn 1 since 1956 might be taken, therefore, to imply an increment of about 30 m rad per annum under conditions of no weathering or other removal by rain.

In deriving the population dose a factor for weathering must be introduced because washing away of fall-out is to be expected over streets and hard surfaces. Further factors for shielding when indoors must also be used. If, following the Medical Research

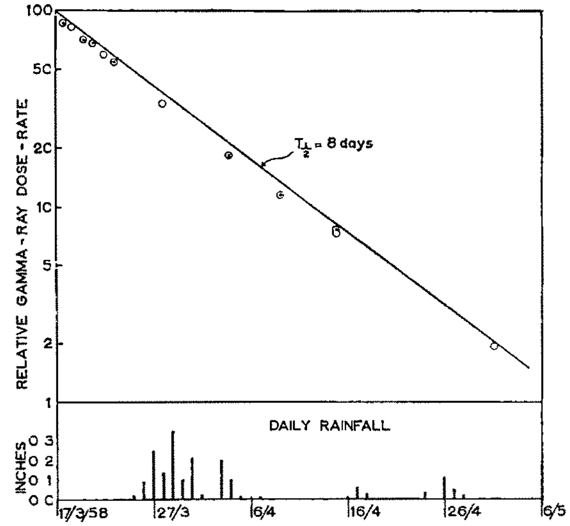

Fig 3. Decrease of dose-rate with time after deliberate contamination of a lawn with iodine-131 to produce an initial dose-rate of about ten times the background-rate, daily rainfall given in inches

Council Report of 1956[1], we assume reduction factors of 3 for weathering and 7 for shielding, and an average period of 2 5 hr a day spent in the open, the implied increase in the dose-rate to the population, above the 1956 level, would be about 2 5 m rad per year The Report of the United Nations Scientific Committee[2] discusses the range of weathering and shielding factors used by different authors and adopts a combined over-all factor of 10 On this basis, the increment of 30 m rad per annum in the uncorrected outdoor dose-rate would lead to an increase of 3 m rad per annum Because of shielding of the gonads by overlying tissues, the increment in the average gonadal dose-rate would be about two-thirds of these estimated external rates or about 2 m rad per year

There are, however, considerable uncertainties as to the values to be used as representative weathering and shielding factors and at present the limited evidence we have collected is insufficient to establish reliably the average change in the dose-rate inside houses At one site, in a ground-floor room facing lawn 1 in Leeds, an increase in dose-rate has been observed which amounts to about 80 per cent of the outdoor value After the Windscale reactor accident, the increase in this room was one-third of the outdoor value and the higher fractional increase now obtained might be taken to indicate the presence of fission products indoors In a single-story laboratory, the background dose-rate increased by 7 5 m rad per annum between October 1957 and October 1958, with a further increase of 4 m rad per annum by July 1959—increments which are about half those observed over lawn 1, but in step with them In a second-floor room in another house no significant change occurred over the period June 1958 to June 1959, during which time the dose-rate over lawn 1 increased by about 5 m rad per annum An average shielding factor for the inside of a house, which depends on the siting of rooms, door and window areas and the presence of neighbouring buildings, is difficult to assess. but it may be less than the value 7 adopted above

The present increase in the gonadal dose-rate may, therefore, be as little as 2 m rad per annum, but this estimate is likely to be low rather than high The increment, however, is greater than the values of 0 25–1 m rad per annum suggested (so far for the year 1957 only) by the United Nations Scientific Committee[2] and it is greater than the average increment in gonadal dose-rate from ingested cæsium-137 which, in 1958, amounted to approximately 1 m rad per annum[2] A probable upper limit to the dose-rate increment can be suggested if the ground-floor observations are regarded as typical of the lower range of building protection factors An average protection factor of about 2 is then implied, leading to an increment of about 4 m rad per annum, if a weathering factor of 3 is used, and about 10 m rad per annum in the unlikely event of no removal of fission products by rain It is probable that the present increment in dose-rate to the population from external fall-out is not greater than 5 m rad per annum The external contribution to the fall-out dose-rate may be expected to decrease with the decay of the zirconium–niobium fission products if no further nuclear bomb tests occur

[1] Marley, W G , Medical Research Council Report on Hazards to Man of Nuclear and Allied Radiations (Cmd 9780), 121 (London, 1956)

[2] Report of the United Nations Scientific Committee on the Effects of Atomic Radiation, 101 and 109 (1958)

[3] Spiers, F W , *Nature*, **183**, 517 (1959)

[4] Vennart, J , *Brit J Radiol* , **30**, 55 (1957)

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[6] Gustafson, P F , Argonne National Laboratory, Semi-Annual Report, *ANL*-5967 (July–December 1958)

[7] Spiers, F W , Medical Research Council Report (Cmd 9780), 111 (London, 1956)

ADDITIONS TO THE BRITISH MUSEUM (NATURAL HISTORY)

By SIR GAVIN DE BEER, F R S
Director

THE new premises recently taken into service in the Natural History Museum fall into two categories those devoted to the Museum's major task of scientific research, and those devoted to the educational function of providing exhibits illustrating various aspects of natural history and of giving instruction To the former belongs the new Mammal Building, erected to take the place of the old building demolished five years ago to make room for the new boiler house, which provides heating for the surrounding educational establishments in the South Kensington area

Built to the plans of Mr W Kendall, the new Mammal Building stands 110 ft high, consists of 11 floors, and provides 62,500 sq ft of accommodation for housing the national collections of mammals Arranged systematically on each floor, the plan adopted provides for many years of expansion and acquisition of new specimens which will take their place in the collection without the necessity for removing other portions in order to make room The importance of this provision is already seen in the efforts now being made to take advantage of the situation in Central and East Africa, where heavy casualties are inevitably being inflicted on large mammals as the result of policies that have been adopted An opportunity exists which, it is hoped, will not be missed, to collect considerable quantities of skins and skeletons of ungulates, not only because adequately documented specimens of these animals are insufficiently represented in the existing collections but also because it is becoming increasingly important to determine the range of variation of species in Nature, and this necessitates possession of large numbers of specimens

Preservation of mammalian collections presents many problems arising from the change in physical conditions of the atmosphere Research is constantly proceeding into the most effective way of preserving skins, but no amount of precautions would be of any avail unless two major variables of the atmosphere were not kept under control humidity and temperature The new Mammal Building is air-conditioned throughout to maintain the contents within prescribed limits of temperature and moisture

Provision has been made for the accommodation of scientists, both members of the staff and visitors working on the mammal collections, and laboratories have been conveniently placed on the various floors of the building where the specimens can be adequately deployed and studied

The new North Block of the Natural History Museum now accommodates the General Library and Map Room The Library of the Museum is not a public library, but the working equipment of the scientific staff of the Museum to which qualified persons, both trained scientists and students, may be admitted on recommendation The reading room, catalogue room, accessions room, studies for the librarian's staff, and book stores, conform to the most modern standards of equipment Visitors who remember the cramped quarters in which the General Library previously had to carry out its functions will be agreeably surprised at the new library

The Map or Atlas Room is a special feature of the General Library and is provided with ample accommodation for maps in shallow drawers containing a small number of maps each, so that any map can be easily and speedily extracted for study on the tables provided for their deployment Adequate facilities for pin-pointing any place on the entire map-covered surface of the globe, both on dry land and under the sea, play an essential part in the equipment of the Natural History Museum for the work of every one of its five Departments Gazetteers, books relating to topography and reports of scientific expeditions have been specially sited in the new Map Room, which also houses the large folio and double folio volumes too large for shelving elsewhere

The new facilities provided for the discharge of the educational functions of the Museum comprise fresh exhibits and a Lecture Hall

The fifth bay on the western or left side of the Central Hall of the Museum has been set up to illustrate the "Six Milestones of Evolution" These are (1) The origin of life, illustrated by means of molecular models showing Miller's experimental production of the amino-acid glycine from hydrogen, water, carbon dioxide, methane, and ammonia, by means of electrical discharges and ultra-violet light There are also models of adenosine triphosphate and of the Watson–Crick–Wilkins structure of deoxyribonucleic acid constructed on a scale of 2 cm to the angstrom unit by Mr A H Barker

(2) The origin of plants and animals, illustrating the fundamental distinction in methods of nutrition between these two types of life and its consequences An electron-microphotograph of the influenza virus by Dr R E G Wyckoff is also shown, together with examples of exceptions to the normal distinction in feeding mechanisms between plants and animals, such as parasitic plants and animals, and fungi

(3) The origin of sex, traced from the simplest form of protistan cell undergoing fission and fusion without differentiation between the sexes, up to higher plants and animals where the specialization between mobile sperm and immobile food-containing eggs is reflected in all the differences between the individuals of the two sexes

(4) The origin of the multicellular type of organization, of embryonic development, and of death form a compact subject of interrelated processes, illustrated with reference to the potential immortality of unicellular organisms, the mortality of the soma, and the development of the frog from the unicellular fertilized egg to the multicellular adult

(5) The colonization of land by plants and animals, which introduced two important biological consequences the alternation of generations in plants between gametophytes and sporophytes, and, in animals, the production of adaptations permitting eggs to be fertilized and developed out of water These are illustrated by means of models and paintings of algae, mosses, ferns, and flowering plants on one hand, and fish, amphibia, reptiles, birds' eggs, and mammals on the other

(6) Finally, under the head of psycho-social evolution, the briefest possible introduction is given to the phenomenon of non-genetically transmitted inheritance, instruction, and tradition This is illustrated by means of experiments by Dr W H Thorpe on the learning of the characteristic song by young chaffinches from adult chaffinches, pictorial representation of the customs of ancient Sparta, and of the cave art of palæolithic man, the snake of Aesculapius on a surgeon's glove, a microphone and printed page and the shadows of the Houses of Parliament and St Paul's Cathedral

The exhibits were prepared and constructed by Mr Erik Thorn

The North Hall of the Museum has been reopened and contains two sets of popular exhibits which have, unfortunately, had to be withheld from the public for some time One of these is the series of British trees, showing their appearance in summer and winter, with specimens of leaf, bark, flower, fruit and seed The other consists of the series illustrating the importance of accurate identification of organisms for the efficient control of pests, plant and animal An old friend exhibited here is the enlarged model of the flea

Of the domestic animals previously exhibited in the North Hall, the skeleton of 'Brown Jack' and the mounted skin of 'Mick the Miller' are now on view in the Mammal Balcony The remainder of the collection of domestic animals, greatly in need of augmentation, has been transferred to Tring Museum, where it is hoped at some time to establish displays of the breeds of domestic animals

From the North Hall a corridor leads to the Lecture Hall Along the corridor are showcases containing selected large mammals, such as the grey seal, reindeer lion, cheetah, leopard, jaguar, Malay tapir, yak, and two species of zebra In each case, following current museum practice, a map is provided showing the geographical distribution of the animal

Between the entrance doors of the Lecture Hall is an exhibit demonstrating steps in the mounting of mammals for exhibition prepared by Mr A G Hayward, senior taxidermist in the Museum It is sincerely to be hoped that this exacting scientific and artistic technique will never again be referred to as 'stuffing an animal' Facing the entrance to the Lecture Hall are some showcases devoted to the exhibition of notable paintings and drawings illustrating natural history

The Lecture Hall is provided with the most modern equipment for projecting slides and films, and for satisfactory acoustic conditions It accommodates 220 persons, and is used for lectures by the staff of guide-lecturers of the Museum and on other occasions

OBITUARIES

Dr D O Morgan

Dr Daniel Owen Morgan, of St Catharine's College Cambridge, and University lecturer in animal pathology, formerly senior lecturer in zoology, University of Edinburgh, died in Cambridge on November 17, aged sixty-six He was born on August 19, 1893, was educated at Tregaron County School, and after serving as a signaller during the First World War entered the University College of Wales, Aberystwyth, in 1919, reading zoology and agriculture and specializing in helminthology His postgraduate researches were conducted under the supervision of Prof R T Leiper, at the London School of Hygiene and Tropical Medicine, and included studies on the systematics of the trematode family Opisthorchidae, the bionomics of the potato eelworm *Heterodera schachtii*, and a survey of the helminths of domestic and wild animals in Hertfordshire

During the years 1923–33 he held the post of field officer and senior research assistant at the Institute of Agricultural Parasitology of the London School of Hygiene and Tropical Medicine, and during this time published twenty-three papers on parasitological subjects In 1933, he was appointed to a senior lectureship in zoology in the University of Edinburgh and became responsible for the teaching of helminthology to veterinary undergraduates reading for the Royal College of Veterinary Surgeons diploma and the University degree in veterinary science In addition, he was responsible for the postgraduate courses in helminthology for the diplomas of tropical veterinary medicine, tropical medicine and public health while during the War an emergency short course in helminthology for medical officers was his concern

Despite an extensive teaching programme he found time for research, and his outstanding contribution was the study of the helminth population of Scottish hill sheep and the discovery of the 'spring rise' phenomenon of worm egg output in these sheep His work on hill sheep has stimulated numerous researches on this and allied problems both in Great Britain and throughout the world

In 1952 he moved to Cambridge and was responsible for the course in parasitology to veterinary students He greatly loved Cambridge, its life, and was particularly fond of his College, St Catharine's He was a man of abounding kindness and encouragement, and will be remembered by the hundreds of students whom he guided and sadly missed by his colleagues

E J L Soulsby

Mr William Dallimore, I S.O , V M.H

The death of William Dallimore took place suddenly at his home near Tonbridge, Kent, on November 7, in his eighty-ninth year He entered the Royal Botanic Gardens, Kew, as a young student in 1891 and his official connexion with this institution extended over forty-five years His earlier years at Kew were spent mainly in the Arboretum, of which he later had charge It was this close association with a rich collection of living plants in his early years that enabled Dallimore, with his keen powers of observation and a good memory, to build up for himself his great knowledge of trees and shrubs which he was to put to such good effect in later years He was one of Britain's leading authorities on trees and shrubs for half a century, having maintained his keen mental powers to the full until the end of his long life He devoted special attention to the conifers, and his "Handbook of Coniferæ" (written in collaboration with the late A Bruce Jackson), which first appeared in 1923, has remained a standard work

Another of Dallimore's notable achievements was the tremendous part he played in starting and developing the National Pinetum at Bedgebury in Kent, a joint undertaking on the part of Kew and the Forestry Commission, commenced in 1925 The fine specimens of pines and other conifers now to be seen at Bedgebury constitute a fitting, living memorial to him He supervised the raising of these trees from seed in many instances One of the main thoroughfares in the Pinetum has, in fact, been named Dallimore Avenue On his retirement from Kew in 1936, Dallimore moved to Kent to live, and continued to act in an advisory capacity in connexion with Bedgebury almost to the time of his death

At Kew, Dallimore ceased to have charge of the Arboretum in 1909 when he was transferred to the Museum staff, his first task being to initiate and build up a museum of British forestry (now the Wood Museum) His knowledge of arboriculture and forestry was of great assistance to him in this He became keeper of the Museums of Economic Botany in 1926 His published works included two other books, one on pruning and one on holly, yew and box , also numerous articles in horticultural, botanical and forestry journals

The Kew Guild, an association of past and present Kew men, came into being in the early 1890's, largely as a result of Dallimore's initiative and energy He himself became president of the Kew Guild in 1926 Dallimore had other interests besides plants For many years he was an enthusiastic bowls player He was also churchwarden at the Kew parish church With his keen sense of humour and his amusing narratives he was always a popular figure His two daughters survive him

F N Howes

Mr A W. Siddons

In no subject of the curriculum has the method of teaching undergone greater change in the past fifty years than in mathematics Before the turn of the century, the school course contained little more than arithmetic, manipulative algebra and the rote learning (sometimes even in Latin) of Euclid's proofs The revolt was led by Rawdon Levett, mathematics master at King Edward's School, Birmingham, who, through a letter in *Nature* of May 26, 1870, pleaded for the formation of an Anti-Euclid Association It was left to one of his greatest pupils, Arthur Warry Siddons, to see the change effected, Euclid's stranglehold broken and geometry established as a suitable tool for school use

Mr Siddons devoted his whole life to school mathematics, though he might well have attained eminence in the university field. He was a scholar of Jesus College, Cambridge, and was fifth Wrangler in 1898, immediately below Jeans and Hardy. In the following year he read natural science, and again took a first. His only appointment was at Harrow School; here he taught mathematics with increasing brilliance and success until his retirement in 1936, and in these years he earned the affection of generations of Harrovians. In 1902 Jesus College elected him to a fellowship and, in December of the same year at the age of twenty-six, he was appointed to a University Syndicate to discuss mathematical requirements. The report stated that any geometrical proof would be accepted provided it appeared "to form part of a systematic treatment of the subject"; Levett's cherished freedom was achieved. From this time to the end of his busy life, Siddons was engaged in converting the rigid logic of mathematics into a form suitable for young minds. In this his greatest collaborator was Charles Godfrey; as a team they had the ability to put into practice their progressive ideas and, when necessary, to write the appropriate text-books.

In addition to an intensely happy family life and to his devoted service to Harrow, Siddons's great joy was his work with the Mathematical Association. In 1902 he was elected secretary of the newly formed Teaching Committee. The reports prepared by this Committee now cover the whole field of school mathematics, and in preparing many of them, Siddons (and his life-long friend, C. O. Tuckey) took a leading part. The Association recorded its gratitude by electing him as president in 1935—he was the first schoolmaster ever to achieve this distinction—and in 1958 it bestowed the rare privilege of honorary membership.

With all his ability, all this distinction, Siddons was a very simple person. He was a great conversationalist and a most lovable man; in the Harrow tradition he was very fond of singing, and the School on the Hill has cause to remember his genius as a gardener and maker of lawns. He claimed that in his school-days he found mathematics difficult; perhaps this explains his success as a teacher and his passion for simplicity within the limits of exactness. To the end his mind was crystal clear, and he died peacefully in his sleep on November 10. Those who knew him well will miss his warm friendship, and the whole body of teachers and taught in mathematics is grateful for his life and his labours.

W. J. LANGFORD

NEWS and VIEWS

International Scientific Relationships
Dr. Detlev W. Bronk, For.Mem.R.S.

A SPECIAL medal (Fig. 1) has been awarded to Dr. Detlev W. Bronk, president of the Rockefeller Institute, by the Society for Promoting International Scientific Relationships. The award has been made for Dr. Bronk's accomplishments in fostering the promotion of scientific research and international co-operation through exchanges of scholars. The medal was presented on November 24 by Dr. Herman F. Mark, honorary president of the Society and director of the Institute of Polymer Research at the Polytechnic Institute of Brooklyn. At the meeting Dr. Alan T. Waterman, director of the National Science Foundation, delivered an address on "Science and the Progress of Man".

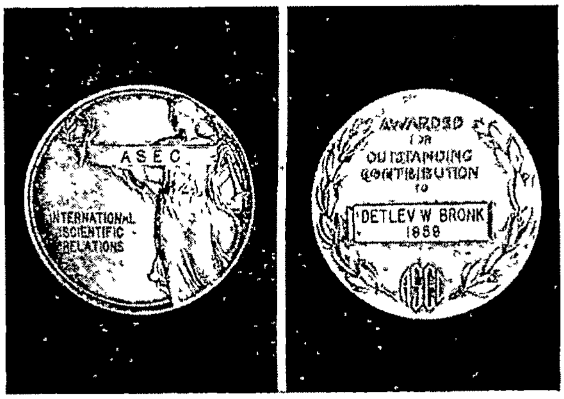

Fig. 1

Bristol City Museums Dr. F. S. Wallis

DR. F. S. WALLIS will bring to a close his long and distinguished service to the Bristol City Museums in May of next year. A Bristol man, he was educated at the Fairfield Secondary School, Bristol, and at the University of Bristol, where his academic career was broken by service in the First World War with the Royal Warwickshire Regiment and the R.F.C., later the R.A.F. He graduated with first-class honours in geology in 1920, and afterwards took his M.Sc., his Ph.D., and finally, in 1930, his D.Sc. He was appointed assistant curator in geology after his first graduation and has devoted his life to the welfare and development of the Bristol Museum and Art Gallery, of which he was promoted to be deputy director in 1930. On the division of the Museum and Art Gallery in 1945, he became director of the City Museum—now 'Museums' as they include the Blaise Castle Folk Museum. He has never forgotten his first love as he has held for more than thirty years the post of special lecturer in sedimentary petrology in the University of Bristol and has since 1936 taken the evening tutorial class in geology there. He has always been interested in adult education and has lectured extensively to members of various organizations in Bristol and the surrounding district. For his field-work he was awarded the Lyell Fund of the Geological Society. In the museums field, he has long laboured for better lay-outs, more didactic exhibits and more artistic displays, and he has not spared himself in extending good ideas and projects of reorganization throughout the museums of the south-west of Britain. He served with unassuming distinction as president of the South Western Museums and Art Galleries Association and also, in 1956, of the national body, the Museums Association, in which he now ranks as an elder statesman. He gave notable service to the Joint Committee of the Museums Association and the Carnegie United Kingdom Trustees, both as a member and for five years as its chairman, in the worthy task of allocating grants for the reorganization of smaller provincial museums. He was war-time editor of the *Museums*

Journal, which did so much to maintain standards and morale at home, to hold and strengthen links with museum men overseas, and to build soundly based plans for museums in the post-War world. It is good that he is to continue to serve his chosen profession as curator of the museum of the Torquay Natural History Society.

Mr. Alan Warhurst

MR. ALAN WARHURST, who succeeds Dr. F. S. Wallis as director of the Bristol Museums, was educated at the Canon Slade Grammar School, Bolton, and the University of Manchester, where he secured honours in history, specializing in the Roman occupation of Britain. He is particularly interested in medieval archæology in its broadest sense and has undertaken field-research in Chester, Kent and Northamptonshire, having published a number of valuable papers. During the War he saw service in India, being commissioned to the Lancashire Fusiliers. His museum service began at the Grosvenor Museum, Chester, then extended to the Maidstone Museum and Art Gallery, where he was deputy curator, and in 1955 to the Northampton Museum and Art Gallery, to which he was promoted curator. There he started a major reorganization scheme and, having completed with notable success the archæological gallery, he was about to commence the boot and shoe gallery.

U.S. Scientific Attaché in India: Prof. E. C. Watson

PROF. E. C. WATSON, dean of the faculty for the past fourteen years at the California Institute of Technology, is retiring to become scientific attaché to the U.S. Embassy in India. Dr. Watson administered the Institute's rocket development programme during the Second World War after having managed in the earlier days the Institute's physics laboratories. He has won national recognition for his studies in the history of science and for his remarkable collection of manuscripts, pictures and prints on the subject. He has published nearly eighty articles in the American *Journal of Physics* depicting the history of physics. This is in addition to numerous scientific papers and a book entitled "Mechanics, Molecular Physics, Heat and Sound". His main research has been in the field of X-ray photo electrons.

National Science Foundation: Dr. Bowen C. Dees

DR. BOWEN C. DEES has been appointed assistant director for scientific personnel and education at the U.S. National Science Foundation. Prior to going to the Foundation in 1951, Dr. Dees served as division chief and physicist with the Scientific and Technical Division of the General Headquarters of the Supreme Commander for the Allied Powers in Tokyo during 1947–51. He had previously lectured on physics at New York University, Mississippi College, the Massachusetts Institute of Technology and Rensselaer Polytechnic Institute. Dr. Dees received his A.B. from Mississippi College in 1937 and his Ph.D. from New York University in 1942.

Nomenclature in Titrimetric Analysis

DURING the Twentieth Conference of the International Union of Pure and Applied Chemistry, held in Munich in August 1959, the Committee of the Analytical Chemistry Section discussed certain points of confusion in the literature. Referring to the notation of indicators in titrimetric analysis, it was pointed out that many dyestuffs recommended as indicators in chelatometric and redox titrations have been given various trivial names. Examples can be found in the literature of a compound being recommended as a new indicator when the compound has in fact been in use for years under a different name. To avoid future confusion, the Committee recommends that when a dyestuff is proposed as an indicator in any type of titration, and particularly when it is claimed as new, the British Colour Index or Schultz Number be quoted in addition to the trivial name. As regards the terminology of complexing agents used as titrants, it is recommended that: (*a*) the group of polyamino-polycarboxylic acids which form anionic complexes shall be termed 'complexans'; (*b*) titration processes in which any type of complexing titrant is used shall be termed 'complexometric titrations'; (*c*) those complexometric titrations which involve titration with a chelating agent shall be termed 'chelatometric titrations' and represent a special type of complexometric titration.

Research Vessel for Woods Hole Oceanographic Institution

A NEW research vessel will be provided for studies in oceanography by a grant of 3,000,000 dollars from the National Science Foundation to the Woods Hole Oceanographic Institution. The new vessel will replace the research vessel *Atlantis*, the twenty-eight-year-old 'flagship' of the Institution's fleet. Because of the probability that the National Science Foundation would be asked to support the construction of research vessels, it made a grant to Woods Hole in 1958 to study capabilities and preliminary designs of various sizes and types of such vessels. This study, in turn, benefited from earlier studies made by the Institution with funds provided by the Office of Naval Research. The vessel will have an overall length of 175 ft., beam of 36 ft., and loaded displacement of 1,040 tons. She will have an operating range of 7,500 miles at a cruising speed of 12 knots. Incorporated in the design are roll- and pitch-damping devices, wide speed control and high degree of manœuvrability, superior laboratory spaces, and excellent working facilities. Preliminary design plans were prepared for the Institution by M. Rosenblatt and Son, of New York. Additional features which have been considered for possible inclusion in the detailed plans and specifications include anti-rolling tanks, acoustical 'quietness' for studying underwater sound characteristics, a gravity laboratory, an aquarium, and ample freezer space for preserving bottom-sediment cores and biological specimens. The total complement of the ship will be 37, of whom 19 will be scientists.

Radiocarbon Dating

THE appearance of Radiocarbon Supplement Vol. 1 of the *American Journal of Science* marks an important step forward in the publication of radiocarbon dates. In the past, date lists have appeared at irregular intervals in a number of journals, making it difficult for potential users of the dates to keep themselves fully informed of all the work in this field. The dating laboratories have been well aware of this problem, but there are considerable difficulties in attempting to use any one of the existing scientific journals with a wide circulation. For this reason, the editors of the *American Journal of Science* are to be commended on this project, which provides a single, relatively inexpensive, annual publication specifically for radiocarbon dates and associated measurements.

This first volume contains thirteen date lists and one paper (Lamont VI) devoted entirely to measurements on samples of known age This aspect of radiocarbon dating research has assumed considerable importance in recent years, for it yields information on the past and present distribution of radiocarbon in the carbon exchange reservoir, and this is of particular importance when one is concerned with the attainment of the highest possible accuracy in radiocarbon dates

In addition to these contributions from dating laboratories, there is a very useful bibliography by Frederick Johnson, which gives references to all previous date lists, and a list of all laboratories known to be or to have been concerned with radiocarbon dating measurements Thirty-six laboratories are listed, and it might be wondered why only about a third of them have contributed to this new publication However, if one takes into account the fact that some have now ceased to be active in this field and that others have only recently begun operating, the response to this new project is not unsatisfactory The editors have attempted to secure a high standard of presentation by requiring contributors to adhere as closely as possible to a set style and to include much informative detail regarding each sample in addition to its laboratory number and radiocarbon age In general, the various authors have responded well to these requirements, and the standard achieved in this first volume promises well for the future The Supplement is to be published annually, in May, at Sterling Tower, Yale University, New Haven, Connecticut, subscription rate 4 50 dollars a year, Vol. 1 will be sold for 2 50 dollars until January 1, 1960

Inland Waterways in Britain

An interesting feature of the sixty-fourth annual report of the National Trust, for 1958–59 (London National Trust), which records a welcome increase in free legacies and donations, is the reference to negotiations with the British Transport Commission for the acquisition of the southern section of the Stratford-upon-Avon canal and the southern section of the Staffordshire and Worcestershire canal Since then it has been announced that, under an agreement to be approved by Parliament, the National Trust will lease the first of these canals for a trial period of five years, when it can be transferred outright or returned to the British Transport Commission. For the five years the National Trust will receive £1,500 a year from the Commission and the Trust will be able to provide in the towpath a thirteen-mile traffic-free walk through a remote and interesting countryside Unless transferred to the Trust, this canal will be abandoned (at an estimated cost of £120,000) and the pleasures of fishing and boating on it would also be lost to the community The second canal is of extreme beauty and importance and is James Brindley's earliest canal with locks The Trust already owns property on this canal at Kinver and Wightwick These transfers, which are foreshadowed in the Bowes Report on Inland Waterways, represent a new departure, both for the Trust and the Commission, and the legal and financial arrangements are not expected to be completed simply or rapidly The report pays tribute to the help given by voluntary workers in scrub clearance, but, although the membership over the past fourteen years has risen from 10,300 to 80,668, many more members are needed if membership is fairly to reflect the wide responsibilities of the Trust and to support the extension of its work.

Newspaper Trusts

In Broadsheet No 435, "The Work of Newspaper Trusts", Political and Economic Planning provides a concise account of the various newspaper trusts, their purpose and character and organization, with a view of assisting the assessment of their performance (*Planning*, 25, 24 August 1959 London Political and Economic Planning, 1959 3*s* 6*d*) The fullest accounts given are of the Scott Trust, holding all ordinary shares in the Manchester Guardian and Evening News, Ltd, and the Observer Trust, but there are also notes on the provisions in the articles of association of *The Times*, *The Economist* and *The Spectator* The Broadsheet points out that the organization of such a trust must be devised for the end to be served, and that many different methods may be adopted Too precise a definition of a trust's aims or ideals could be harmful if circumstances changed To form opinion and build good traditions and to appoint men of good sense to positions of responsibility are all that can wisely or legitimately be done to control the future A newspaper trust is a novel but long-dated attempt to keep a newspaper in conformity with an existing ideal over future generations and it is still too early to judge how far these experiments have contributed to maintain the health and standards of the Press It remains to be seen whether trusts can be more successful than other forms of proprietorship and control in preserving and developing the independence and character of a newspaper and simultaneously in achieving sufficient success to stay in business, if not to lead the field

British Museum (Natural History)

Among the more important and interesting items reported to the Trustees of the British Museum at their meeting at the British Museum (Natural History) on November 28 was that Dr G. H Francis and Dr. A J Charig had returned from their expedition to South Peru This expedition, the second from the Museum to this area, had for its objective the further study, collection and mapping of the rocks of the Province of Carabaya, in the Department of Puno, together with fossil collecting from new sites in Carabaya The mapping, field geology and detailed study of igneous rocks were in the charge of Dr. Francis, of the Department of Mineralogy, continuing the work begun on the previous expedition which he led in 1954 The fossil and anthropological collections were made by Dr Charig, of the Department of Palæontology They were assisted by Messrs S G McH Clark and B L Holt, University of Cambridge, and by Sr. H Salazar Dias, University of Arequipa. The expedition was in the field from June 1 until August 1, 1959 More than four hundred specimens of rocks and minerals were collected in the present field season The survey of the area was continued, and a substantial number of fossils were assembled In addition, the expedition brought home some anthropological material from Inca burials Mrs Rees Thomas and Lady Barlow have lent to the Museum a letter from Charles Darwin, dated July 5, 1844, asking his wife to arrange for the publication of his Essay on Transmutation of Species in the event of his death The latter has been placed on exhibition in the case of Darwin relics, now on view in the Central Hall of the Museum

Tanganyikan Stratigraphy

An authoritative and up-to-date account of the stratigraphy of Tanganyika is now available in English as a result of the work of members of the Tanganyika Geological Survey (Memoir No 1 "Summary of the Geology of Tanganyika, Part 1 Introduction and Stratigraphy", by A M Quennell, A. C. M. McKinlay, and W G Aitken, 1956 , 264 pp , The Government Printer, Dar es Salaam, 20*s*) This memoir was prepared in draft in 1956 and used as the authority for the preparation of Lexique Stratigraphic International, Vol 4, "Afrique", Fasc 8c, "Tanganyika" (1957), but has only recently become available owing to delays in publication Important revisions to the pre-Karroo stratigraphy have been made The basement complex has for some time been known to contain rocks of different origins and ages in different areas, and several attempts at subdivision have been made as the structural and metamorphic history of the country has become better known On the basis of the existing evidence, the present authors have adopted a five-fold subdivision, the systems being named in order of decreasing age the Dodoman, Nyanzian, Kavirondian, Usagaran and Ubendian, Karagwe-Ankolean, and the Bukoban Systems The Dodoman System is correlated with the oldest known rocks of Africa, and the uppermost Bukoban is thought to be possibly Eocambrian

The Institute of Metals

The following members have been elected to fill vacancies on the Council of the Institute of Metals with effect from the annual general meeting on March 29, 1960 *President*, Sir Ronald Prain, chairman and president, Rhodesian Selection Trust, Ltd , *Vice-Presidents*, Dr. H M Finniston, research manager, C A Parsons and Sons, Ltd , and H W Hignett, assistant managing director, Henry Wiggin and Co , Ltd. , *Ordinary Members of Council*, Dr R W K Honeycombe, professor of physical metallurgy, University of Sheffield , Dr Ivor Jenkins, chief metallurgist, Research Laboratories, General Electric Co , Ltd , E Robson, managing director, Manganese Bronze and Brass Co , Ltd , J Salter, director, British Aluminium Co , Ltd , and C. Smith, works director, James Booth and Co , Ltd

Physical Society Exhibition

The Physical Society Exhibition will be held at the Royal Horticultural Society's Halls, Westminster, London, S W 1 (just behind Victoria Street from Artillery Row), from January 18 until 1 p m on January 22 The opening ceremony will be performed in the New Hall on January 18, 1960, at 11 a m , by Mr A J Philpot (chairman of the Exhibition Committee and vice-president of the Physical Society) in the unavoidable absence of the president of the Physical Society Lectures will be given by Flight Lieut J Billingham (R A F Institute of Aviation Medicine) on "Some Reactions of the Human Body to the Stresses of High Performance Flight" on January 18 , Dr L Essen (National Physical Laboratory) on "Atomic Time" , and Dr D A Wright (Research Laboratories of the General Electric Company, Ltd) on "Recent Advances in Solid State Physics" The lectures will be at 5 45 p m Further information can be obtained from the Society, 1 Lowther Gardens, Prince Consort Road, London, S W 7.

University News : Birmingham

The title of reader in mathematical physics has been conferred on Dr J G Valatin Dr. D A Bell, reader in electromagnetism, and J T Allanson, senior lecturer in electrical engineering, have been appointed joint acting heads of the Department of Electrical Engineering until September 30, 1960, in the absence of Prof D. G Tucker, who is on study leave The University has accepted the offer of Joseph Lucas, Ltd , to finance a Fellowship in the field of metal joining in the Department of Industrial Metallurgy for a period of seven years Research fellowships have been awarded as follows Dr Florence J Pepper (zoology) , Prof L P V Johnson (genetics) , M J Harrison (physics) , and H Mueller (biochemistry) The following appointments are also announced Dr H B Griffiths, to be lecturer in pure mathematics from July 1, 1960 , and Dr J K Brown, to be lecturer in chemistry from January 1, 1960

Oxford

The following research grants are announced from British Petroleum Trading, Ltd , £3,000 spread over three years for the purpose of continuing a research fellowship in geochemistry , and from the du Pont Company, U S A , 3,000 dollars for the year 1960–61, for the support of basic research in the field of theoretical chemistry in the Institute of Mathematics, under the direction of Prof C A Coulson

Announcements

Prof. E. G Cox, professor of inorganic and structural chemistry in the University of Leeds, is to succeed Sir William Slater as secretary of the Agricultural Research Council on Sir William's retirement next year Prof Cox's appointment will take effect from July 1, 1960

The eleventh Annual Lecture of the Plastics Institute will be delivered by Lord Verulam, who will speak on "The Brink of the Unknown" The meeting will be held in the Reardon Smith Lecture Theatre, National Museum of Wales, Cardiff, on April 7, at 6 30 p m

A symposium on Organic-Phosphorus Compounds will be held on January 29 in the Department of Chemical Technology, Bradford Institute of Technology Those taking part include Dr B C Saunders (University of Cambridge), Dr D J. Tuck (University of Nottingham), Dr C B Reese (University of Cambridge), and Dr A F Childs (research director, Albright and Wilson (Mfg), Ltd) Further particulars can be obtained from the Registrar, Institute of Technology, Bradford 7.

The Non-Destructive Testing Group of the Institute of Physics will hold a meeting in London during May 2–4 jointly with the Société Française de Métallurgie The programme will have the general theme of the relationship between structure and physical properties of materials and will include recent advances in non-destructive testing techniques Further information can be obtained from the Secretary, Institute of Physics, 47 Belgrave Square, London, S W 1

Erratum We regret that in the article entitled "Counter-current Distribution of Proteins in Aqueous Polymer Phase Systems" in *Nature* of November 7, p 1465, the blocks for Figs 2 and 3 have been interchanged , the legends, as printed, stand

INTERNATIONAL SYMPOSIUM ON MACROMOLECULES, WIESBADEN

THE annual International Symposium on Macromolecules, held under the auspices of the Commission on Macromolecules of the International Union of Pure and Applied Chemistry, this year took place in Wiesbaden, Germany, during October 12–17 Almost 1,200 people registered for the Conference, which must have been the largest of this series ever held About half the delegates were from Germany and the remainder came from twenty-four other countries, with France, the United States and Great Britain supplying the largest delegations

Organization of a symposium on the above scale must obviously be highly efficient if the work of the Conference is to be carried out, and the organizers deserve the highest credit for the arrangements they made Meetings were held mainly in two large halls in the magnificent new Rhein-Main Halle, the acoustics of which were excellent The general plan of the meetings was as follows The Symposium was divided into five sections (1) Physics of Macromolecular Substances, (2) Macromolecular Substances in Solution, (3) Elementary Processes and Kinetics of Polyreactions, (4) Chemistry of Organic and Inorganic Macromolecular Substances; and (5) Macromolecular Natural Substances and Model Compounds Every day, a plenary lecture was given on some topic from one of the five sections For the remainder of the morning, sessions of two sections were held simultaneously, at each of which three lectures were given that were essentially reviews rather than original scientific papers In this way, practically the whole of the current field of polymer progress was summarized The official languages of the Symposium were German, French and English, and during the morning sessions, translations of the text of the lectures were projected on to two screens behind the speaker, the third central screen being reserved for slides On the whole, the system worked very well, provided the lecturer stuck to his text

The afternoons were devoted to consideration of the numerous short communications, in each of the five main sections, about forty communications, which were intermediate in length and character between a paper and an abstract, had been submitted Discussions of at least two, and sometimes three, sections were held simultaneously in the various halls, about twelve short papers, together with the morning lectures, being discussed at each session While at some sessions the time allocated for discussion was more than adequate, at others the time for discussion of some papers was quite inadequate, and the chairman seemed more concerned to keep to his average 'driving speed' than to promote full discussion. This is a problem that besets all conferences, but perhaps the very size of this one made flexibility of arrangements more difficult (It is only fair to say that numerous participants of the Symposium found no fault at all with the arrangements for discussions)

Faced with more than thirty full lectures, and two hundred short communications, even the most indefatigable student of macromolecules feels surfeited, and becomes highly selective in his attendance For this reason, and because at least two sessions were held simultaneously both in the morning and afternoon, I cannot give a full account of all aspects of the Symposium The following summary covers what seemed the most interesting and significant features of the lectures and papers

In the field of the physics of polymers, there was considerable interest and activity in studies of the mechanism of crystallization and the morphology of crystalline polymers The lectures by A Keller (of Bristol) and W A Kargin (of Moscow), in particular, aroused lively discussions Kargin and also S R Usmanov (of Tashkent) presented the case that polymers that are normally regarded as partly crystalline, such as cellulose, are not truly crystalline in any sense, since they do not pass certain thermodynamical criteria, such as the presence of transition points, and should be regarded only as highly ordered Keller reviewed current opinions on the structure of spherulites and the exciting recent developments in forming macro-crystals of polymers in which the polymer chains are folded back on themselves The other main branches of physics on which attention was centred were dielectric and mechanical relaxation phenomena, nuclear magnetic resonance, and the thermal behaviour of polymers

The study of the properties of solutions of polymers obviously still commands considerable attention, from both the theoretical and the practical points of view P Debye (of Ithaca) presented a new method of estimating molecular interactions from measurements of light scattering, and this gave hope that ultimately a new experimental tool for estimating intermolecular forces would develop Rheological and viscosimetric studies, and in particular the deduction of molecular dimensions from these, comprised one section, while another dealt with the thermodynamics of polymer solutions, and the quantitative determination of parameters such as the virial coefficients, etc Of considerable interest to experimentalists were a lecture by F Patat (of Munich) reviewing osmotic pressure techniques and results, and papers by C Kruissink (of Delft) on the theory, and H -G Elias (of Munich) on the practice, of using membranes partially permeable to the solute Further refinements of conventional methods of measuring molecular weights and molecular weight distributions were described, but there did not seem to be any major new developments in this field

In the section on elementary processes and kinetics of polyreactions, several lively sessions were held One topic that naturally aroused much interest was ionic polymerization, with special reference to stereospecific polymerization Valuable interpretative reviews were given by G Natta (of Milan) on stereospecific polymerization, M Szwarc (of Syracuse, U S A) on anionic polymerization, and M Magat (of Paris) on ionic polymerization initiated by ionizing radiation There were also, of course, numerous short contributions on these topics Ionic polymerizations are attracting considerable attention at present, as a result of the enormous commercial developments following the pioneer work of Ziegler and Natta, and it is certain that, despite the enormous work effort, much yet remains to be discovered The present conference provided some evidence that development has outpaced theory and interpretation, and once this is remedied, and the runners in the race get their second wind, more exciting progress will be made

Fortunately 'steam-radio' (that is, free radical) vinyl polymerizations continue to be studied, with the work perhaps best described as being in the consolidation state Valuable reviews of the applications to polymer studies of radioactive labelling and electron spin resonance were provided by J C. Bevington and D H Whiffen, respectively (both of Birmingham) The industrially very important process of polymerization in heterogeneous media attracted some attention

A session was held on the polymerization of caprolactam, at which all the papers were given by workers on the Continent

One section was devoted to the discussion of natural polymers and model substances W Kuhn (of Basle) gave a fascinating lecture on the production of mechanical energy by macromolecular systems Current interest in polypeptides was reflected by lectures by T Wieland (of Frankfurt) on the organic chemistry of the formation of peptide links and C H Bamford (of Maidenhead) on synthetic polypeptides In these two lectures, a fascinating contrast between the ingenuities of the organic and the physical chemist was displayed Close as are these two studies to the processes of life itself, some studies that were reported on nucleic acids, cancer, and enzyme action were even closer, and demonstrated the extensive range of topics to which polymer science has a major contribution to make

Starch and cellulosic chemistry was also treated in several contributions and lectures by E Husemann (of Freiburg) and H Sihtola (of Helsinki) One interesting new discovery by Ø. Ellefsen (of Oslo) was the preparation of a new crystalline modification of cellulose Only a few papers were given on rubber, including a review by W F Watson (of Shawbury) of recent work on the mechanochemical reactions of polymers

A very interesting section was that on what might be termed the preparative chemistry of organic and inorganic polymers. A review of new condensation polymers was given by H Mark (of New York), this included an elegant demonstration of 'interfacial polycondensation', by means of which high-molecular weight polyamides are formed virtually instantaneously at room temperature The happy term 'Instant Nylon' has been coined in the United States for this polymer The application of classical organic reactions to vinyl polymers leads to many interesting new products, and progress in this field was summarized by G J Smets (of Louvain) Considerable interest is being currently shown in inorganic, and organic/inorganic polymers, and this was reflected in numerous short papers as well as set lectures by E Thilo (of Berlin), H Deuel (of Zurich), H Krebs (of Bonn) and S Nitzsche (of Burghausen) Various unusual organic polycondensation reactions, and methods of forming cross-linked polymers and block copolymers, also received attention

It will be obvious from the above, highly inadequate, summary that there was scarcely an aspect of polymer science that did not receive attention Whether this is the best programme for a conference is a matter for debate, as it can be argued that limitation of the subject-matter promotes a fuller and deeper discussion There can be no doubt, however, that the Symposium once again fulfilled its main purpose of bringing together polymer scientists and promoting fertile interchanges of views

Some of the main lectures have already appeared in *Die Makromolekulare Chemie*, and the remainder, together with the discussions, will appear in later issues

L VALENTINE

INDUSTRY AND THE TECHNICAL COLLEGES IN BRITAIN

AN important paper on the relationship between industry and technical colleges was presented at a conference arranged by the Liverpool District of the Federation of British Industries at Chester on October 21 The speaker, Mr L S Newton, of Pilkington Bros, Ltd, suggested that, despite the increased attention being paid by industry to the education and training of its personnel, there are three ways in which many firms are still not making a real contribution to the development of the educated man-power of Great Britain

Many firms are still evading their responsibility for training young people and are content to recruit their craftsmen, technicians and technologists from other companies Industry should accept the opportunity provided by the 'bulge' to analyse its requirements for the next ten to fifteen years to see how many young people it could now absorb to train for later years Many firms also do not provide facilities for part-time release for study in the day-time—this applies not only to industry but also to professional and commercial undertakings Industry frequently fails to discriminate between the branches of study, the facilities for commercial students remaining quite inadequate

A feature of post-war development has been the remarkable rise in the number of students being released for sandwich courses. The number of students attending the technical colleges full-time or on a sandwich basis has risen tenfold in the past twenty years, between 80 and 90 thousand being in attendance at the moment What the ultimate ratio should be has not yet become clear, but industry's support for sandwich courses is far from uniform and largely in the hands of the larger and more progressive companies

Mr Newton's most important contribution to the conference, however, was concerned with the ways in which closer co-operation between industry and the technical colleges could be achieved.

There are four main places where action could be taken to establish, maintain and foster relationships between the two bodies for their mutual benefit (*a*) there should be a closer tie at the policy-making level, (*b*) there should be a closer tie at the point at which the contents of syllabuses and courses are determined, (*c*) there should be a closer tie at the teaching level, and (*d*) there should be a greater sharing of responsibility for the success of the student

Probably the most important contribution that industry can make is to participate in policy formulation for the organization and administration of technical colleges by serving on college governing bodies and departmental advisory committees Some colleges are still governed by a committee which is a sub-committee of the local further education committee, which itself is a sub-committee of the education committee of the local authority "Moreover, we view with increasing concern the growing intrusion of local political issues into the deliberation of some governing bodies which has a discouraging effect on industrial participation "

Industry must co-operate in the teaching of technical colleges partly by encouraging more of its qualified young men and women to accept part-time teaching posts in the colleges and also by releasing, where necessary, men of appropriate skill and knowledge to teach on a part-time day basis Sandwich courses in particular need teachers with close and current contact with industrial problems, these are not always to be found—nor could they be fully and efficiently employed in the technical college Industry can offer another valuable service—that of taking in the full-time teacher for periods of refreshment in current practice Local education authorities are empowered to release teachers for up to 12 months for industrial experience without loss of pension rights

Since industrial firms supply the great majority of students, they must keep the college generally informed of their education requirements—qualitatively and quantitatively They must keep the colleges informed of the latest developments in their specialized fields and of the needs to which the college can contribute They must support the colleges in their activities and assist them in carrying out their job—whether by loaning staff or equipment or giving them the benefit of their knowledge in the advisory or administrative fields They must consult with them on all matters of joint interest and maintain a constant flow of information in both directions

The conference was attended by 140 representatives of education and industry from north-west England

MODERN NETWORK THEORY IN ELECTRICAL ENGINEERING

THE first phase in the development of network theory was opened by the work of Ohm in 1827 and may be regarded as being terminated, at the end of the nineteenth century, by the work of Heaviside By this date the main concepts and methods of network analysis were established and although mathematicians more orthodox than Heaviside were yet to present operational methods in a different light, little other work of significance appeared between 1900 and 1922 The subsequent growth of network theory was greatly stimulated by the use of the notion of a complex frequency, a concept which, in its turn, grew out of the application of the theory of functions of a complex variable to those problems of time-variation in networks which had previously been treated by the methods of Heaviside

With the introduction of more powerful mathematical tools it became possible, in the second and present phase in the growth of network theory, to treat the problems of realizability, synthesis, approximation and practical design, that is to say, which mathematical functions may be realized as network characteristics ? How may networks having prescribed, realizable, characteristics be found ? By what approximations may a desired physical response be most usefully and economically translated into a set of realizable mathematical functions ? In what manner do the general mathematical processes of realization and synthesis require to be treated if the outcome is to be a practicable network using a comparatively small number of relatively cheap components ?

These are some of the questions with which modern network theory is concerned, and to discuss them the Department of Electrical Engineering of the University of Birmingham organized an informal conference which took place in that Department during September 21–24 The main purpose of the conference, believed to be the first on this subject to be held in Britain, was to give ample opportunities for the discussion of network problems, and the lectures and papers which were presented took up only one-half of the time of each session in order to permit this In a limited space it is not possible to give equal treatment to every paper and discussion, but it is hoped that the nature of some of the problems discussed will be made clear by the following account

Of all the sessions, the first was the most fundamental and abstract but also at the greatest remove from any immediate relevance to practical problems Mr P R Bryant (General Electric Co , Wembley) spoke on a topological analysis of the order of complexity of an electrical network The 'order of complexity' was defined as the number of the natural frequencies of an electrical network and this number was shown to be equal to the number of dynamically independent network variables In order to prevent too naive an approach to this work it is only necessary to point out that a network of n capacitors connected in series possesses an 'order of complexity' of n, whereas the network formed by connecting the capacitors in parallel is of order 1 The other paper in this session was presented by Dr V Belevitch (C E C E , Brussels) and was concerned with a treatment by matrix algebra of the realizability theory for general linear, stable networks with n terminal-pairs

A discussion on a group of papers on networks with parameters varying with time was opened by the authors—Prof D G Tucker, Mr D P Howson and Mr J M Layton (University of Birmingham) A major part of the discussion centred on the possibility of applying, to networks with parameters varying with time, theorems developed from a study of networks with constant parameters That care is needed in making translations of this kind was shown by a demonstration in one of the papers that the input impedance of certain rectifier modulators was dependent on the nature and magnitude of the impedance associated with the source used to provide the input voltage and current This result is more surprising than the discovery that theorems such as those of Thévenin and Norton cannot usefully be applied to many networks varying with time Much more work is required to define the types of networks to which the main results of classical theory may be applied, and it is evident that the analysis of networks containing reactances varying with time presents many problems, not the least of which is that of determining the conditions for stability

In the third session Dr O P D Cutteridge (Manchester College of Science and Technology) spoke on the application of a particular continued-fraction expansion to a range of problems of active and passive networks The expansion may also be used to determine the character of the zeros of a polynomial

A lengthy discussion was initiated by a paper on the synthesis of three-terminal resistance-capacitance networks, presented by Mr J T Allanson (University of Birmingham) There exists no complete solution to the problem of designing a network of this kind if the three impedance functions of the network are specified It can be shown, by analysis of real networks, that the impedance matrix for any three-terminal resistance–capacitance network must necessarily satisfy certain conditions it can also be shown, by synthesis of networks, that if an impedance matrix satisfies a more extensive set of conditions a network of this type may be found to represent the matrix The paper and the discussion were concerned with attempts to close the gap between these two—the necessary and the sufficient—sets of conditions

A discussion of a similar kind took place after Dr W Saraga (Siemens Edison Swan, London) had discussed the analysis and synthesis of reactance networks in terms of the 'one-points' of various functions The traditional methods of analysis and synthesis have regarded the poles and zeros of various network functions as constituting the most easily handled specification of these functions, but there are certain advantages in using the values taken by the complex frequency variable when the functions in question have the values of ± 1 However, the simplicity of procedure which results from using these 'one-points' in network synthesis has to be paid for by an increase in the number of network elements required to realize a given set of functions In practical applications these redundant elements must be removed and the series of network transformations necessary to do this may be sufficiently complicated to nullify the advantages of the preceding simplicity It appears that 'one-point' analysis may be most usefully applied as complementary to pole-zero analysis in revealing useful general relations in networks

Dr G S Brayshaw (University of Leeds) presented a paper dealing with an application of positive-real graphs and Dr A Talbot (Imperial College, London) discussed the use of Tchebyscheffian approximations in network synthesis, and outlined an algebraic method for the determination of rational approximating functions suitable for filters required to have Tchebyscheffian characteristics in both pass and stop bands

In the fourth session of the conference two papers were read on the design and construction of filter networks Mr E R Austin (Post Office Research Station, London) outlined a computational procedure for obtaining, in the form of a ladder network, an image parameter filter in which advantage is taken of the theoretical possibility of specifying independently the attenuation and impedance characteristics The design may be regarded as yielding a filter more efficient than the corresponding Zobel type but less so than one designed on an insertion loss basis Dr J H Mole (H M Underwater Detection Establishment, Portland) spoke on problems of component design, accuracy and tolerance, mechanical construction and the testing and measurement of practical filters

The final session of the conference was taken up with a discussion on the place and teaching of electrical network theory in universities and technical colleges Mr F E Rogers (The Polytechnic, London), Dr A W Keen (Coventry Technical College), and Mr E R Broad (Post Office Research Station, London) opened the discussion, which was vigorous but inconclusive However, it was agreed that more attention must be paid to the physical and mathematical fundamentals underlying the practical techniques for the solution of network problems and less time given to these techniques themselves

J T ALLANSON

BRITISH OVERSEAS INFORMATION SERVICES

IN a written statement circulated in reply to a question in the House of Commons on November 16 as to the implementation of the proposals in the White Paper on Overseas Information, the Chancellor of the Duchy of Lancaster, Dr C Hill, stated that since April 1, 1959, the British Council has recruited 140 teachers of English for overseas posts, and expenditure on exchanges of university teachers with foreign countries has risen from £6,164 in 1958–59 to about £9,014 for 1959–60, for Commonwealth exchanges the corresponding figures are £12,113 and £16 113 The number of scholarships awarded by the Council has risen from 284 in 1958–59 to 355 in 1959–60, and of these 98 and 141, respectively, were related to the teaching of English, including twelve new scholarships for students from the Colonial territories for teaching English as a second language, 14 studentships at the University of London Institute of Education for United Kingdom graduates intending to teach English overseas, and fifteen new posts concerned with the teaching of English established overseas Educational exchanges with Czechoslovakia and Hungary have commenced, including a three-week visit to British universities of six professors from Czechoslovakia Government grants to the British Council were estimated at £5,824,000 for 1959–60, compared with £4,615,000 in 1958–59

Expenditure on British Council libraries was £234,000 in 1958–59 and will rise to about £480,000, for books and periodicals for presentation, the corresponding figures are £39,000 and £72,000 In consultation with the Governments concerned, twenty new British Council libraries have been, or will shortly be, set up, and long-term lending library services for students are now operating or will shortly operate at nine Council centres and through universities Libraries of the long-lending type are already operating in Karachi, Rawalpindi and Dacca and in process of being extended to Lahore and Chittagong, and first indications are that they are a great success More than 30,000 books have been sent out and 235 additional subscriptions to periodicals provided for

Council libraries in India since April 1, 1959 , for Pakistan, the corresponding figures are nearly 40,000 and 104 Measures to promote exports of British books and periodicals are making good progress, and proposals have been put to the Governments of Indonesia, Israel, Pakistan, Poland and Yugoslavia with the aim of agreeing upon schemes broadly on the lines of the former British book export schemes Trade organizations in the periodical field have been consulted on measures to assist circulation of newspapers and periodicals in some of the more difficult markets overseas

In broadcasting, Dr Hill said that excellent progress has been made with the construction of the new relay transmitter at Berbera, and the Arabic Service of the B B C is now transmitting for 12 hr daily compared with 4 5 hr in 1957 Efforts have been made to increase both the local and general appeal of the Service, and arrangements have been made to provide the local Press and broadcasting services in East Africa and Aden with more material on the background in the news A conference of the Governments of the East African territories, Aden and the Somaliland Protectorate in March 1959 provided a valuable interchange of information and ideas, and the re-appraisal of the Overseas Service of the B B C in English, nearing completion, has given full weight to the special importance of increasing the appeal of these Services to the rapidly growing number of listeners overseas for whom English is a second language Studies have been made of the possibility of introducing television in Aden

With regard to official services, a United Kingdom Information Office has been opened in Kampala and premises in Nairobi are being equipped , expenditure on television material for showing overseas is expected to be £138,000 in 1959–60 compared with £121,000 in 1958–59, and all the expansions recommended in the Central Office of Information Services have been made or are in progress These include improvements in the Press and telegraph services, a radio-type service for local broadcasting in Arabic, Somali and Swahili , the completion of three experimental television films for the British Council on the teaching of English , increased supply of trade and technical periodicals overseas and an expanded programme of overseas visits, especially on the Commonwealth side A Commonwealth Exhibition, intended as the focal point of 'Commonwealth Weeks' in several major cities, was opened in Liverpool on November 19 The cost of the Overseas Information Services in 1959–60 is now estimated at about £16 5 million a year, while measures to promote exports of British publications will cost about a further £500,000 a year

METALLOGENIC MAPS

THE notion and the term metallogenic or metallogenetic are due to L de Launay, who in 1900 proposed the terms 'metallogenic provinces' and 'metallogenic epochs' Respectively, these two terms meant a particular geographical region or a specific geological epoch characterized by a particular assemblage of mineral deposits The representation of such a province or provinces on the map led to the construction of metallogenic maps Such a map differs from what is called a 'mineral map' A mineral map only shows the distribution of one or several mineral deposits, while the aim of a metallogenic map is not only this but also to relate the distribution of such deposits to the geological formations or periods and to the tectonic features of the region This leads to the discovery of particular areas of distribution or zones of occurrence , changes in the character of mineral deposits in time , association of certain chemical elements among the deposits, and many other features .

During the past few decades the problem of construction of metallogenic maps of various countries or on an international basis has been discussed At the International Geological Congress held in Mexico City in 1956 a Sub-Commission for the Metallogenic Map of the World was created During March–April 1958 this Sub-Committee, as a part of the wider Commission of the Geological Map of the World, met in Paris (*Nature*, 182, 502 , 1958) At this meeting a number of metallogenic maps of different countries were shown and discussed and the future programme outlined

In the U S S R the problem of metallogenic provinces, epochs and maps were particularly discussed by the late Y A Bilibin (1901–52) and S S Smirnov (1895–1947), and at the present time this work occupies the forefront of geological research Valuable contributions to the metallogeny of various ores were recently made by N S Shatsky, discussing the manganese ores (*Bull Acad Sci U S S R* , *Ser Geol* , 4, 3 , 1954), and phosphorite deposits ("Conf Sed Rocks, Acad Sci U S S R ", 2, 7 , 1955) The metallogeny of Kazakhstan has been discussed by K I Satpaev (*Bull Acad Sci U S S R* , *Ser Geol* , 6, 34 , 1953) and A I Semenov (*Soviet Geology*, 58, 110 , 1957) The principles of regional metallogenic analysis have been discussed by V I Serpukhov (*Soviet Geology*, 43, 27 , 1955) The principles of metallogeny and the construction of metallogenic maps are discussed by E T Shatalov (*Bull Acad Sci U S S R* , *Ser Geol* , 9, 37 , 1958) An attempt at a general metallogenic survey of the territory of the Soviet Union and the construction of a metallogenic map of the U S S R was made by V I Smirnov (*Bull Acad Sci U S S R* , *Ser Geol* , 4, 3 , 1959 and *Priroda*, 4, 17 , 1959) Recently, E A Radkevich (*Bull Acad Sci U S S R* , *Ser Geol* , 5, 125 , 1959) has published a report of the All-Union Metallogenic Conference held in Alma-Ata during December 1958, at which 800 delegates and visitors were present and a number of papers read and discussed A valuable summary of the work done in the Soviet Union in this field combined with a manual for the preparation of metallogenic maps has been published in book form It is edited by P M Tatarinov, V G Grushevoy and G S Labazin, and it is entitled "General Principles of a Regional Metallogenic Analysis and of the Methods of Compilation of Metallogenic Maps of Folded Regions", published by "Gosgeoltekhizdat", Moscow, 1957 (150 pages , price 7r 20k) This volume contains seven articles dealing with the general principles of a regional metallogenic analysis, sedimentary and igneous formations, mineral deposits complexes, metallogenic zones and methods of compilation of metallogenic maps

S I TOMKEIEFF

ULTRASONICALLY DISPERSED SODIUM

By M. W. T. PRATT and R. HELSBY

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MANY chemical reactions involving sodium benefit from the use of the metal in a highly dispersed form. The surface area available for reaction is then very large: for example, the surface area of spherical particles of sodium 1 micron in diameter is 6×10^4 sq. cm. per gm. Recently, we have prepared, by an ultrasonic technique, much finer dispersions of sodium in hydrocarbons than can be made by the high-speed stirring methods most commonly used.

The production of sodium dispersions ultrasonically is simple; a molten mixture of sodium and hydrocarbon dispersing medium is ultrasonically irradiated for a few minutes under an inert atmosphere (a patent has been applied for to cover the process). A laboratory apparatus capable of producing 200-gm. quantities of sodium dispersions by this method is sketched in Fig. 1. An ultrasonic magneto-strictive transducer with a resonant frequency of 25 kc./s. is sealed by a 'Neoprene' ring into a cylindrical 'Pyrex' reactor (15 cm. × 6 cm.). Ultrasonic irradiation is applied to a molten charge of sodium and dispersing medium at a power of approximately 250 W. for about 10 min., until the colour of the dispersion becomes constant, indicating that the equilibrium state of dispersion has been reached. The dispersion is then forced out of the reactor by pressure of inert gas into a container, from which the air has previously been displaced by inert gas.

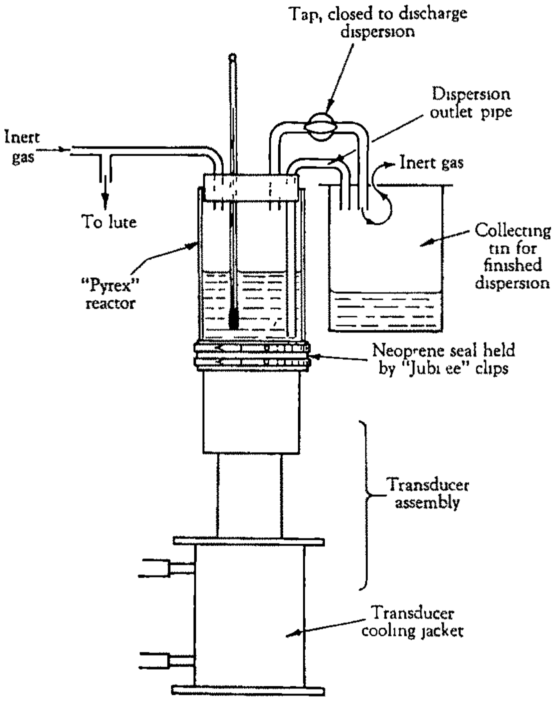
Tap, closed to discharge dispersion
Dispersion outlet pipe
Inert gas
Inert gas
To lute
Collecting tin for finished dispersion
"Pyrex" reactor
Neoprene seal held by "Jubilee" clips
Transducer assembly
Transducer cooling jacket

Fig. 1. Apparatus for the preparation of small batches of ultrasonically dispersed sodium

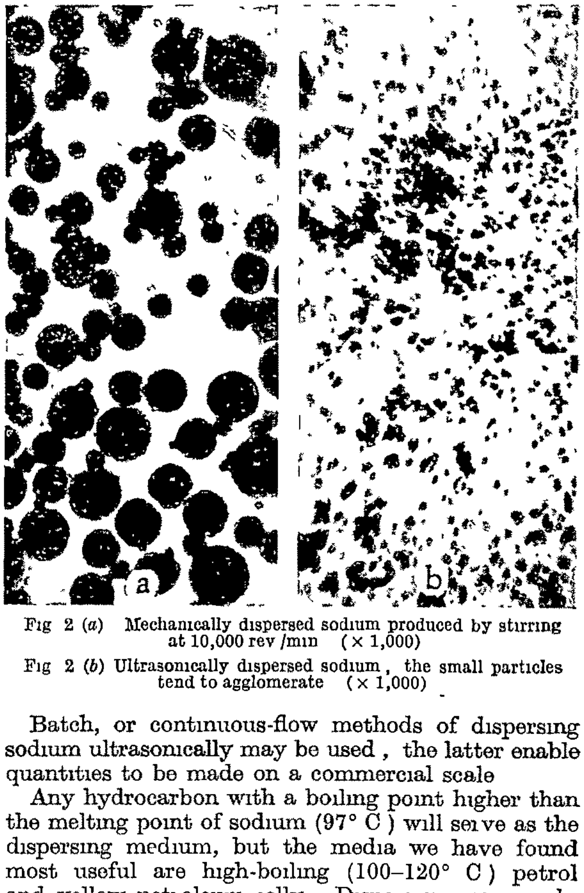

Fig. 2 (a). Mechanically dispersed sodium produced by stirring at 10,000 rev./min. (× 1,000)

Fig. 2 (b). Ultrasonically dispersed sodium; the small particles tend to agglomerate (× 1,000)

Batch, or continuous-flow methods of dispersing sodium ultrasonically may be used; the latter enable quantities to be made on a commercial scale.

Any hydrocarbon with a boiling point higher than the melting point of sodium (97° C.) will serve as the dispersing medium, but the media we have found most useful are high-boiling (100–120° C.) petrol and yellow petroleum jelly. Dispersions can easily be made ultrasonically containing 15 per cent sodium by weight in petrol and 25 per cent by weight in petroleum jelly. Sodium particles in fluid hydrocarbons are rapidly attacked by air and water, and should be used immediately after preparation. Sodium dispersed in yellow petroleum jelly reaches an exceptionally fine state of subdivision, possibly due to the presence of a natural dispersing agent in the jelly. The sodium particles in this paste-like medium are protected from attack by air and moisture, so that the dispersions keep well, and can be safely transported. The sodium is liberated for reaction either by melting the jelly, or dissolving it in petrol; to avoid decrease in reactivity, this must be done under an inert atmosphere.

Stirring molten sodium and dispersing medium together mechanically at 10,000–20,000 rev./min. produces grey-coloured dispersions in which the particles are mainly between 3 and 15 microns in diameter. A photomicrograph of a typical mechanically produced dispersion in petroleum jelly is shown in Fig. 2a. Nearly all the particles in ultrasonically dispersed sodium in petroleum jelly are 1 micron or

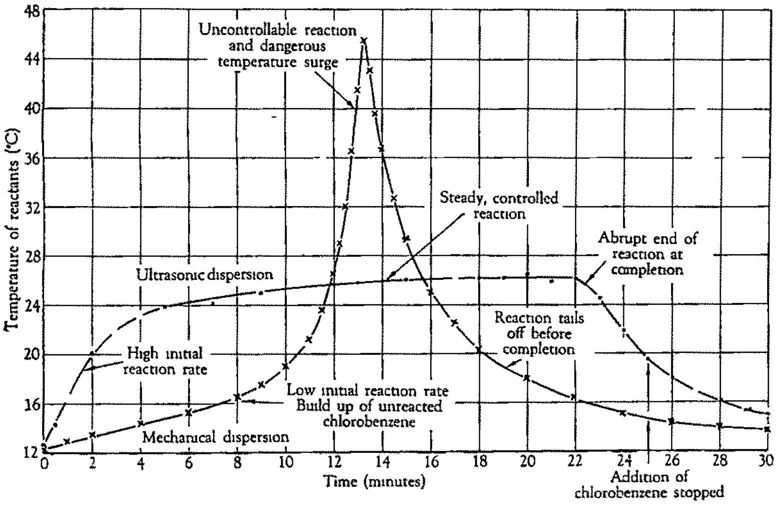

Fig 3 Comparison of the reactivities of sodium dispersed mechanically and ultrasonically

less in size (Fig 2*b*), and these dispersions have a deep blue or purple colour This colour is probably due to the scattering of light by the small particles, analogously to the production of the blue colour of the sky by the light-scattering effect of dust particles

Having established that ultrasonic techniques enable sodium to be dispersed to a higher degree than is possible by rapid stirring, we showed that the extra fineness produces advantages in chemical reactions greater than those gained by the use of mechanically dispersed sodium This is well demonstrated in the exothermic reaction between sodium and chlorobenzene to produce sodium phenyl This reaction is sometimes difficult to initiate, even when the best mechanically dispersed sodium is used However, when sodium ultrasonically dispersed in petroleum jelly is used (afterwards dissolved for reaction in 100–120° C petrol), reaction is always initiated at once, even at 20° C, which is a low temperature for this reaction The reaction-rate is 10–20 times greater for ultrasonically dispersed sodium than for the mechanically dispersed metal

In experiments performed with small quantities of reagents, chlorobenzene was added continuously, at the rate of 0 5 ml per min, to 6 gm of sodium dispersed in petroleum jelly, afterwards dissolved in 150 ml petrol Fig 3 shows that, under these conditions, ultrasonically dispersed sodium immediately reacts at a high rate (indicated by the rapid rise in the temperature of the reactants towards its equilibrium value) and the reaction is smooth and controllable Under the same conditions, mechanically dispersed sodium is not able to react quickly enough to prevent a build-up of unreacted chlorobenzene, eventually the accumulation of chlorobenzene reacts at an accelerating rate, and an uncontrollable temperature surge occurs When this reaction has been carried out on a large scale, using mechanically dispersed sodium, temperature surges have sometimes been sufficient to boil the dispersing medium, and serious explosions have followed

It is therefore advantageous to use ultrasonically dispersed rather than mechanically dispersed sodium in the preparation of sodium phenyl, and this is likely to be the case for many other reactions also The benefits commonly claimed for the use of mechanically dispersed sodium instead of the bulk metal can now be extended in higher degree to the use of ultrasonically dispersed sodium, for which the advantages may be summarized as follow

Faster reaction rates are obtained as a consequence of the large surface area of a fine dispersion

Improved reaction control follows, for there is no accumulation of unreacted material, and the sodium can be added at an easily and precisely regulated rate

Temperatures can be lower due to the high reactivity of the dispersions Sudden temperature surges, which may occur with the use of bulk or mechanically dispersed sodium, are eliminated, and the reaction temperature may be held within close limits

Elimination of side reactions frequently results from the use of low reaction-temperatures

Higher yields result from the above advantages, and also because dispersions are completely consumed in conditions in which an insoluble reaction product coats the surface of bulk sodium, and prevents the reaction of a large fraction

Replacement of more complex reagents such as sodium alkoxides, sodium hydride, and sodamide by sodium dispersions is possible in reactions which do not proceed satisfactorily with the bulk or mechanically dispersed metal

Chemical reactions in which these advantages are likely to result include Claisen condensations, Wurtz reactions, preparation of sodium alkyls, aryls and alcoholates, metalations, replacement of active hydrogen atoms and the purification of hydrocarbons

We are grateful to many colleagues in Imperial Chemical Industries, Ltd, who designed and built the ultrasonic equipment we used

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SWELLING FORCES IN STRAINING CLAYS

By E. L. GREACEN
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IT is generally accepted that the compression and swelling of a clay saturated with sodium ions is described by the osmotic theory of swelling[1–3] This theory is based on osmotic effects associated with the adsorbed layer of ions in clays[4,5], and relates the thickness of the water layer between two clay plates to the swelling pressure[2] In the case of calcium clays, however, although the virgin compression curve agrees reasonably well with the theoretical curve, the subsequent swelling on decompression does not Warkentin, Bolt and Miller[3] concluded in this regard that either an unspecified attractive force was operating or that the osmotic swelling force was somehow diminished If these conclusions can be

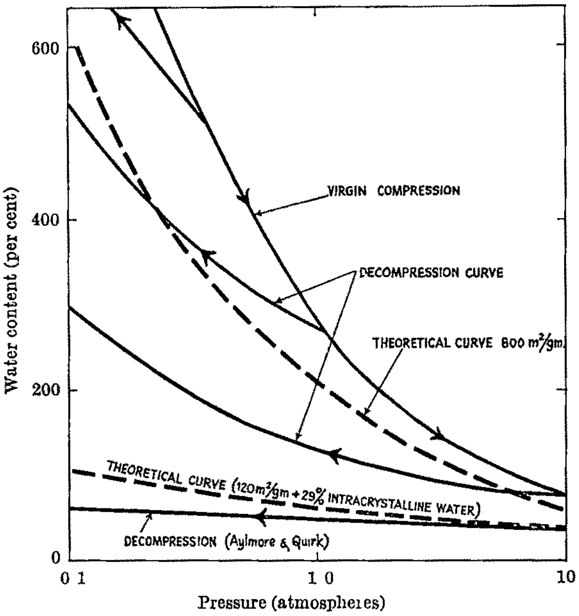

Fig 1 Compression and decompression curves for calcium clay with theoretical swelling curves

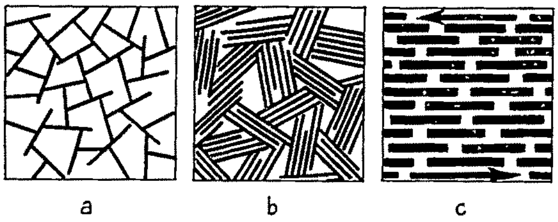

Fig 2 Possible structure in (*a*) flocculated clay, (*b*) consolidated clay, (*c*) illite clay in the ideal straining *CVR* condition

accepted, they suggest an explanation of the behaviour of clays when they are strained under load

Recently, however, Aylmore and Quirk[6] have questioned the interpretation of these results on the grounds that for the calculation of film thickness Warkentin *et al* took as the specific surface of their calcium montmorillonite a value of 800 m^2/gm, whereas Aylmore and Quirk found that for a similar clay 648 m^2/gm out of a total surface of 760 m^2/gm was intracrystalline and not operative, giving an effective surface of only 112 m^2/gm They concluded that the osmotic theory of swelling does not apply to clays saturated with calcium ions

The point of difference can be explained readily by reference to Fig 1 In order to overcome the above objection, I have plotted the results of Warkentin *et al* as water content, in the place of film thickness, against the applied pressure I have also included a probable swelling curve for Aylmore and Quirk's clay from the results they have given The theoretical curves (broken lines) give calculated pressures for values of film thickness which would exist for the two cases where (i) the whole surface, 800 m^2/gm, is active and (ii) where approximately only one-seventh, 120 m^2/gm, is active and the curve is corrected for intra-crystalline water[6] It appears that the calcium clay is becoming compressed from the virgin condition against a pressure that is somewhat higher than would be expected even from an osmotically active surface of 800 m^2/gm I conclude that a separated plate model (Fig 2*a*) is suggested by the results, and that this becomes compressed progressively to the condition shown in Fig 2*b*, similar to that proposed by Aylmore and Quirk

The interesting feature of the curves of Fig 1 is the apparent relation between the theoretical swelling curve and the *CVR* line[8] of soil mechanics When a virgin compressed clay is strained under shear, it becomes compressed further to a state where the voids ratio (water content) is in equilibrium with the compression load, this is called the critical voids ratio state and a plot of the critical voids ratio against the effective pressure is known as the *CVR* line Furthermore, when an over-consolidated clay, that is, one that has been compressed and then unloaded to some point on the decompression curve (Fig 2), is strained under a shear stress, it swells to an equilibrium voids ratio which is described by the same *CVR* line[7,8] Consider now the model for the calcium clay during virgin compression Edge to face bonds, or short-range attractive forces which could operate under the conditions of Fig 2*a*, will assist the osmotic swelling force in resisting volume change during compression, but on the other hand they will oppose swelling forces during decompression This explains why the theoretical curve falls below the virgin compression curve in Fig 1 Further, if we accept the unique nature of the *CVR* line for a straining clay, it follows that short-range forces are not operating at all during shear, but that the *CVR* state represents a balance between only the osmotic swelling pressure and the external force It is suggested that when a compressed clay (Fig 2*a*, *b*) is strained under shear, the short-range forces are overcome, and the clay plates are fully oriented (Fig 2*c*) at a spacing outside the range of these forces I have described[9] a rheological model consisting of friction bodies and springs which allows for this explanation of the *CVR* state

In Fig 3 the *CVR* line[10] is given with compression and swelling curves[11] for a sample of London clay This soil is illitic, with clay ($<2\mu$) content 69 per cent, specific surface 88 m^2/gm, and 15 m equiv of

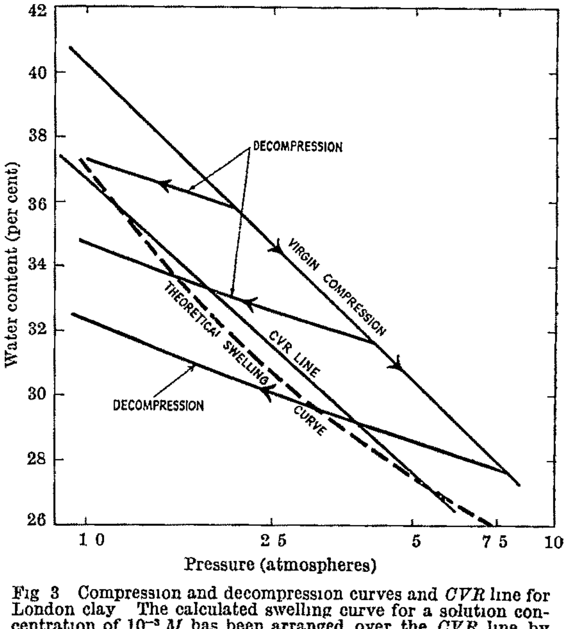

Fig 3 Compression and decompression curves and *CVR* line for London clay The calculated swelling curve for a solution concentration of $10^{-3} M$ has been arranged over the *CVR* line by a 'dead' volume correction of + 26 A

exchangeable calcium out of a total exchange capacity of 19 m equiv /100 gm (ref 12) From the above data the specific surface for the clay fraction is about 120 m ^{2}/gm , which is the value for illite used by Bolt and Miller[2] A value of 10^{-3} M has been assumed for the soil solution concentration, although this is not critical On the assumption that the change in volume of the clay fraction accounts for the change in volume of the whole soil, I have calculated a theoretical swelling pressure curve This curve has been arranged over the *CVR* line by correcting for a dead volume of water equivalent to a film thickness of 26 A According to Bolt[1], this dead volume represents the volume of water which, due to the geometry of clay particles, cannot be expelled from the soil by compression For London clay a correction for dead volume of 30 A places the theoretical curve exactly over the virgin compression curve , for Weald clay, for which parallel data are available[10-12], a value of 36 A is required These agree with the 30–40 A shift found by Bolt for a prepared illite It should be noted that, although the position of the theoretical curve relative to the *CVR* line depends solely on the dead-volume correction, the two curves have the same slope This shows that the osmotic theory can account for the change in volume of calcium illite under these conditions

The above model also suggests a method for testing the existence and effect of long-range attractive forces in clays Since such forces will oppose osmotic repulsion during both swelling and compression, their presence should not deny the unique nature of the *CVR* line as would short-range forces On the other hand, since for a given external pressure the osmotic theory requires approximately double the interparticle spacing for a sodium compared to a calcium clay, one might expect the effect of long-range forces to differ for the two systems Any such difference would at present be lost in the dead-volume correction

The above results do not prove conclusively that the simple osmotic theory is applicable to calcium clays, but they do show that it can provide a reasonable working hypothesis in an otherwise obscure field It should not be lightly discarded The theory could be tested by measurements of the degree of orientation obtained during compression and compression with shear Further progress seems to lie in a more critical estimation of the *CVR* concept and of the dead-volume factor for both sodium and calcium clays in the straining condition

Acknowledgment for helpful discussion is due to Drs W W Emerson and K Norrish and Mr J W Holmes, all of the Division of Soils of this Organization

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A SPECIFIC RESPONSE IN THE HIPPOCAMPUS OF THE RABBIT TO OLFACTORY STIMULATION

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THE olfactory bulb projects to the piriform lobe through the lateral tract and through the more medial radiation which is continuous with the anterior limb of the anterior commissure The distribution of these tracts within the piriform lobe has been described in experimental material stained by the method of Glees[1,2] Terminations are seen mainly in the prepiriform cortex, anterior olfactory nucleus, olfactory tubercule and central amygdaloid nucleus The projection to the last-named area is probably derived from the medial radiation rather than from the lateral tract, and is bilateral No terminations have been seen in the hippocampus or in the septum The distribution in the piriform lobe of electrical responses to olfactory stimulation is substantially compatible with the histological findings[3-5] An electrical response in the hippocampus to single electrical stimuli applied to the olfactory bulb has however been claimed[6] but not confirmed The purpose of this article is to describe a large and consistent electrical response in the hippocampus of the rabbit that can be obtained by suitable repetitive stimulation of the olfactory tracts

Electrical recordings were made from an insulated needle with a bare tip of diameter 10μ placed in the pyramidal cell layer (Ammon's horn) of the hippocampus while electrical stimuli were applied to a radial pair of needles placed in the olfactory peduncle to stimulate both the medial radiation and the lateral tract Stimulation at a frequency less than 8 per sec sometimes elicited very small evoked responses in the hippocampus At a frequency of stimulation between 8 per sec and 20 per sec , however, large evoked responses invariably occurred throughout the dorso-ventral extent of the ipsilateral hippocampus, but only after 50–100 stimuli had been delivered At frequencies between 20 per sec and 230 per sec no hippocampal response was seen, but if the stimulation rate were switched down to 5–20 per sec after 50–100 stimuli had been delivered at a higher frequency, large evoked hippocampal responses were obtained after 5–10 stimuli had been given at the slower rate

Evoked hippocampal responses were obtained by stimulation of the medial radiation alone, but not by stimulation of the lateral tract alone If, however, repetitive stimulation were suddenly switched from electrodes in the medial radiation to electrodes in the lateral tract while the hippocampus was responding, the responses continued unchanged except for a small increase in latency The same result was obtained on switching from the ipsilateral to the contralateral medial radiation, for hippocampal responses can be continued but seldom started by contralateral stimulation A similar switching of repetitive stimulation from the medial radiation to the central cut end of the optic, sciatic or vagus nerves immediately terminated the evoked hippocampal responses Moreover, if repetitive stimulation were applied both to one of these nerves and to the medial radiation until hippocampal responses were obtained, the evoked responses ceased at once if the olfactory stimulation were stopped while the nerve stimulation was continued These hippocampal responses in the rabbit are therefore specifically related to the olfactory system

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The hippocampal response first appears after 50–100 stimuli as a small deflexion with a latency of 40–60 msec , but with 5–10 more stimuli the latency decreases to 20–24 msec and the full amplitude of up to 3 mV is attained With repetitive stimulation at 8 per sec this response persists for 30–40 sec after which the amplitude declines and the latency increases until the response disappears again with a latency of 60 msec Apart from rare immediate recurrences, no further response can then be obtained until 90 sec have elapsed without stimulation, although the response can be recalled for a few seconds by an early high-frequency tetanus If the repetitive stimulation is stopped when the hippocampal response has just attained the full amplitude there is a brief after-discharge

Electrical recordings have been made at different depths in the hippocampus to identify the elements responding (Fig 1) Negative wave-forms are seen at the level of the pyramidal neurones in area CA_1 but positive wave-forms appear at the level of the dendrites in the upper blade of the dentate gyrus, and persist in area CA_4 and in the rest of the dentate gyrus Recordings on other electrode tracks show a negative response in area CA_2 but not in area CA_3

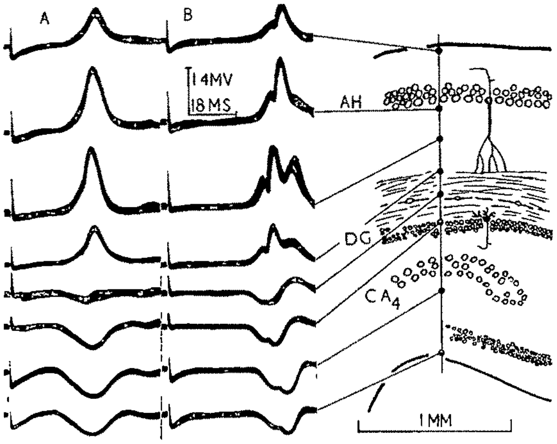

Fig 1 Electrical recordings made at different depths in the dorsal hippocampus of a rabbit anæsthetized with urethane during the stimulation of the ipsilateral olfactory peduncle at 8 per sec The diagram shows the positions of recording on a tracing of a frontal section through the needle track A single neurone has been represented in the Ammon's horn with the apical dendrite below the cell body, and the axon above In the dentate gyrus another single neurone is represented with the dendrites above and the axon below the cell body *A*, the wave-forms recorded after 10 sec of stimulation , *B*, after a further 30 sec of stimulation, negative polarity upwards , *AH*, area CA_1 of the Ammon's horn , *DG*, upper blade of the dentate gyrus

The interpretation of these findings is that only the pyramidal cells of areas CA_1 and CA_2 respond to the stimulation The same distribution of potentials is seen throughout the dorso-ventral extent of the hippocampus

This hippocampal activity might be expected[7] to lead to visceral changes Recordings of visceral activity show that the blood pressure rises slightly and the respiration is often increased in the period between the beginning of olfactory stimulation and the occurrence of the hippocampal response When the latter appears the blood pressure starts to fall, the respiration is reduced, and the bladder and rectum contract These latter effects soon pass off, but the fall of blood pressure continues as long as the hippocampus continues to respond, and the total fall may exceed 40 mm mercury When after 30–40 sec the hippocampal responses cease, the blood pressure promptly rises again although the stimulation is continued The low level of blood pressure is not the cause of the eventual failure of the hippocampal response, for the latter may occur at 80 mm mercury after a fall from 120 mm mercury, whereas a hippocampal response can be started with olfactory stimulation at a blood pressure of 40 mm mercury though not at 25 mm mercury

These visceral changes coincide with, but are not in fact caused by, the activity of the hippocampus, for the fornix can be cut on both sides and the hippocampus dissected out with a sucker without affecting the visceral changes It was found that the electrical responses of the hippocampus were unaffected by cutting the fornix or the fimbria, but were abolished by section of the angular tract of Cajal[8] at a position ventral to the point of recording This finding, together with the fact that the shortest latency of the hippocampal response is 2–3 msec less in the ventral than in the dorsal hippocampus, implies that impulses reach the dorsal hippocampus by ascending the angular tract from the piriform lobe Activity of neurones in the latter concurrent with the hippocampal response is believed to cause the visceral changes Similar visceral effects can be elicited by direct stimulation in the prepiriform cortex after ablation of the hippocampus Impulses are presumably relayed from the prepiriform cortex to autonomic centres in the hypothalamus or brain stem

Electrical recordings have been made throughout the piriform lobe during olfactory stimulation in order to trace the olfactory impulses to the hippocampus Responses to single shock stimulation of the lateral tract were found ipsilaterally in the olfactory tubercule and throughout the prepiriform cortex as far caudally as the periamygdaloid cortex The responses had a latency of 2–5 msec to first inflexion and reversed sharply in polarity, being positive dorsal to the cell bodies and negative ventrally in the region of the axo-dendritic synapses Similar responses and some later deflexions were obtained in these same areas, and also bilaterally in the amygdaloid complex, with single shocks applied to the medial radiation in the olfactory bulb after cutting the visible part of the lateral tract

When repetitive stimulation is applied to the medial radiation the primary responses described above continue , large secondary responses appear throughout the piriform lobe but not in the posterior superior entorhinal cortex at the same instant that the hippocampal response appears These secondary responses vary in latency from 6 msec in the olfactory tubercle to 18 msec in the amygdala At any position of recording the latency gradually increases after 10–20 sec. of stimulation. In the amygdala and in the caudal prepiriform cortex the secondary responses eventually disappear at a latency of 50–60 msec. at the same time that the hippocampal response disappears. In the olfactory tubercule and in the more cranial prepiriform cortex, however, the secondary responses increase in latency to about 20 msec., but may persist indefinitely with continued stimulation. The secondary responses are negative in polarity dorsal to the pyramidal cell bodies (where the primary response is positive), and reduced in amplitude but still mainly negative in polarity ventrally where the primary response is negative.

After recordings had been made at each placement, stimulation was applied to the needle electrode in the prepiriform cortex and further recordings made from the hippocampus. It was found that a large hippocampal response can often be elicited by single shock stimulation of the prepiriform cortex at intervals of not less than 1–2 min. With more rapid repetitive stimulation a hippocampal response was obtained only after many stimuli had been applied, the number increasing at more cranial placements of the stimulating electrode. The hippocampal response to stimulation at the more cranial placements gradually increased in latency and eventually disappeared, but stimulation in the more caudal prepiriform cortex elicited earlier hippocampal responses which persisted indefinitely with continued stimulation.

The primary responses in the prepiriform cortex to single shock stimulation of the lateral tract or the medial radiation were unchanged when the stimulation was made repetitive until the secondary responses appeared in the piriform lobe and hippocampus. At this instant the primary response was slightly reduced, and with continued stimulation the primary response progressively decreased to about a third of the initial amplitude at cranial positions of recording, or about a tenth of the initial amplitude in the periamygdaloid cortex. When the hippocampal response disappeared the primary response partially recovered, but complete recovery never occurred during continued stimulation. Complete recovery required at least 40 sec. without stimulation. This inhibition of the primary response took place without apparent change of latency and was not due to hippocampal activity, since it was unaffected by section of the fornix and angular tract.

The inhibition of the primary response increases at more caudal positions of recording, and so does the amount by which the latency of the secondary response can increase. These results suggest that the olfactory impulses are relayed through many neurones in the prepiriform cortex towards the ventral hippocampus, and that both excitatory and inhibitory connexions are activated. It was found that when small lesions were made in the prepiriform cortex, degenerating axons could afterwards be traced caudally by the Nauta-Gygax technique. Many of these axons end in the prepiriform cortex, but others continue in layer 1 through the entorhinal cortex to the subiculum of the ventral hippocampus. It will be of interest to see whether the remarkable changes of latency that occur in transmission through the prepiriform cortex are common to other systems in which multiple short and long connexions are made.

A specific relationship of the hippocampus to the olfactory system is unexpected[9,10], for the spontaneous electrical rhythms of the hippocampus can be changed by afferent impulses of any modality[11]. The specificity of the large hippocampal responses in the rabbit to olfactory stimulation may be a quantitative effect due to the relative numbers of afferent impulses reaching the hippocampus from different sources, and must be tested in other species of mammals.

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ACCUMULATION OF RADIOACTIVE IODINE IN THYROID GLANDS SUBSEQUENT TO NUCLEAR WEAPON TESTS AND THE ACCIDENT AT WINDSCALE

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THE changes in thyroidal content of iodine-131 in grazing animals due to nuclear weapon tests have been shown to be a sensitive method of detecting fall-out of iodine-131 (refs. 1–5). From their observations that a similar concentration of iodine-131 was found in all thyroid glands tested, irrespective of whether they were from carnivores or from herbivores, Gunther and Jones[3] tentatively concluded that the iodine-131 had been absorbed by these animals through the lungs, having been inhaled as an aerosol. Doubt was shed on this suggestion by the results of Van Middlesworth[2], who showed that the concentration of iodine-131 in human thyroids was never more than 0.5 per cent of the maximum observed in cattle. This suggested, in so far as the grazing animal is concerned, that the alimentary tract may be the main route of entry of iodine-131. This was confirmed by Marston[5], who found very little or no iodine-131 in the thyroid gland of cats, dogs and rats at a time when the concentration of iodine-131 in herbivora grazing on pasture in the same region was high Stall-fed sheep had an activity of less than 0 1 per cent of the activity of grazing sheep

In this report, values for the iodine-131 content of the thyroids of sheep grazing in north-east Scotland are given These values cover the period November 1957–July 1959 Values for deer thyroid glands from north-east and from north-west Scotland and for human thyroids from the London area have been obtained during the period December 1958–March 1959 Shortly after the accidental release of iodine-131 from Windscale No 1 pile on October 10, 1957, sheep thyroid glands were obtained from the Cumberland area during the period October 1957–March 1958

All the measurements of activity reported were made using a commercial scintillation detector fitted with a 2½-in well-type crystal By the addition of an extra 2 in of lead to the top and sides of the detector, the background radiation count was reduced to approximately 500 counts per 100 sec When the detector was calibrated with a standard iodine-131 solution, it was found that 5 0 × 10^{-12} c gave a count-rate sufficiently high to be statistically greater than background, at 95 per cent probability All estimates made were determined by measuring the time taken for 10,000 counts , hence the standard deviation of all counts will be constant

An initial sample of sheep thyroid glands was collected at local abattoirs from sheep of known origin, trimmed free of connective tissue, weighed, homogenized and the count-rate determined on both lobes separately These thyroids were recounted at weekly intervals over a period of a month The half-life of the gamma-activity was found to be 8 0 ± 0 1 days and the decay curve, plotting the logarithm of activity against time, was linear and parallel to that of pure iodine-131 It was found that the presence of muscle tissue did not significantly affect the counter calibration with reference to iodine-131, so that the thyroid content of iodine-131 could be accurately expressed in absolute units, that is, curies All results are expressed in terms of iodine-131 content per gram of fresh weight of thyroid tissue All values are corrected to time of slaughter A statistical analysis of the iodine-131 content of the right and of the left lobe revealed that no difference existed between them (P = 95 per cent) Afterwards, only one lobe was collected from each animal sampled

In order to compare the effect of locality within the general region of north-east Scotland, groups of approximately ten lobes were collected from three batches of sheep from different areas slaughtered on the same day and the iodine-131 content determined The results were

Fyvie	2 91 ± 0 28 × 10^{-10} c /gm	(8 animals)
Oldmeldrum	2 14 ± 0 12 × 10^{-10} c /gm	(10 animals)
Banff	3 34 ± 0 84 × 10^{-10} c /gm	(10 animals)
Overall mean	2 79 ± 0 32 × 10^{-10} c /gm	(28 animals)

There is no significant difference between these groups (0 2$<P<$0 3)

It should be noted that these localities lie more on the coastal belt of north-east Scotland rather than in the more mountainous hinterland This general area, from which the majority of the values to be reported were obtained, has a fairly uniformly distributed rainfall of approximately 30 in a year The main advantage in drawing samples from this area is that it is possible to obtain these samples at regular intervals throughout the year This is not the case with animals from the more mountainous areas with higher rainfall The majority of the flocks sampled were from localities at least ten miles distant from the sea In this region the prevailing wind is south-westerly and therefore off-shore The possibility of sea spray depositing non-radioactive iodine on the pasture during in-shore winds is not considered to have materially affected the results obtained

At certain times of the year it was only possible to obtain the thyroid lobes from fat lambs It was therefore necessary to carry out a comparison between the activity of ewe and lamb thyroid glands The results for one such comparison is given below

Ewe thyroid activity	4 21 ± 0 35 × 10^{-11} c /gm	(16 animals)
Lamb thyroid activity	7 14 ± 0 64 × 10^{-11} c /gm	(8 animals)
Overall mean	5 2 ± 0 42 × 10^{-11} c /gm	

The mean for the activity of the lamb thyroids is significantly higher than that for the ewe ($P <$ 0 01) From other experiments carried out in this laboratory on the thyroid activity in ewes and lambs, it would appear that the difference between the iodine-131 content of their thyroids will vary according to whether the measurement is made during a period of accumulation due to recent fall-out of iodine-131 or during a period when the iodine-131 in the pasture is decreasing The lambs, having more active thyroids than the mature ewes, would accumulate fall-out more rapidly than older animals and also excrete iodine more rapidly The maximum difference is likely to be relatively small, considering that the overall magnitude of change encountered is of the order of one thousand times

In order to obtain some information on what proportion of the thyroid content of iodine-131 could be attributed to absorption through the lungs and ingestion from drinking water, 16 wethers were randomly selected from a flock during a period of relatively low activity, namely, January 1958 Of these animals a group of 8 was brought indoors, where they were kept until slaughter in May 1958, that is, some five months later During this period they were fed on hay and oats harvested during the previous season and kept under cover to preclude contamination by direct fall-out The remaining 8 animals were allowed to run on normal pasture until slaughter Both groups of animals were killed in May 1958 at a time when thyroidal activity due to fall-out in the groups of sheep was known to be high The activity found in the thyroid glands of these two groups was

Stall-fed animals	1 56 ± 2 2 × 10^{-11} c /gm
Grazing animals	2 25 ± 0 13 × 10^{-9} c /gm

The values found for the stall-fed animals are significantly higher than the minimal detectable level and higher than some values obtained from sheep on free grazing during other periods, suggesting that the stall-fed animals had been exposed to iodine-131 by inhalation and from drinking water The hundredfold difference in these values suggests that in so far as the sheep is concerned, the main source of thyroidal iodine-131 is contaminated pasture, something of the order of 0 5 per cent arising from inhalation and drinking water

Having established the validity of the counting and sampling techniques, arrangements were made to carry out regular determinations at approximately fourteen-day intervals The values obtained are presented in Fig 1, which includes histograms indicating the frequency and number of atomic weapon tests and the distribution of rainfall

From the graph it can be seen that the minimal detectable level of 5 × 10^{-12} c /gm is reached 2–3

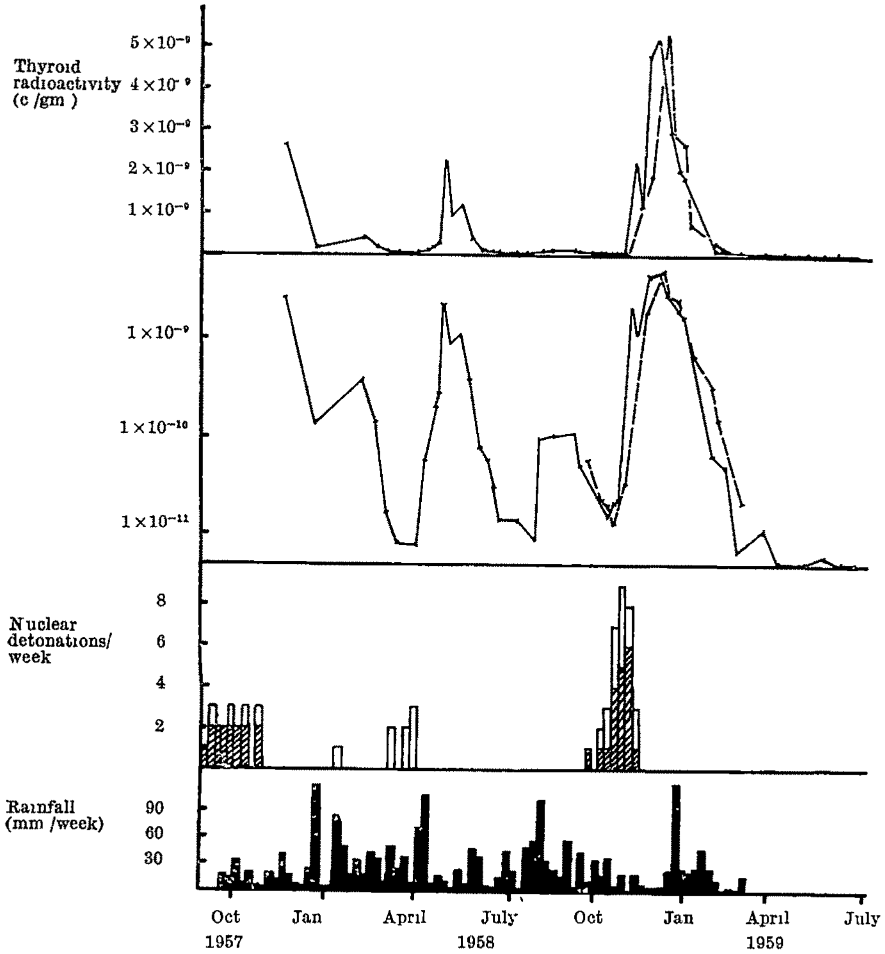

Fig. 1. Variation in thyroid iodine-131 content of sheep in the north-east of Scotland during November 1957–July 1959 with histograms indicating the frequency of nuclear detonations in the northern hemisphere and the rainfall. Nuclear detonations are indicated as shaded (United States tests), unshaded (U.S.S.R. tests)

Superimposed on the upper graphs between September 1958 and February 1959 is the iodine-131 content of deer thyroids collected in north-western Scotland (broken line)

months after a test series. This is in keeping with a half-life of approximately 7 days for iodine-131 in the thyroid of sheep. This value of 7 days takes account of both the biological and the physical half-life of iodine-131 in the thyroid.

It has been supposed that only tests carried out in the northern hemisphere would influence iodine-131 levels in this area. However, it is not possible to relate the increased level found between July and September 1958 with any known northern hemisphere test immediately prior to this period. The Russian series of tests which commenced on February 23 ended on March 21 and did not commence again until September 30. All the American and British tests during the period April 28–August 12 were carried out in the southern hemisphere. It would appear, therefore, that either some unknown release of iodine-131 into the atmosphere took place in the northern hemisphere during this time, or that the debris from tests in the southern hemisphere had been detected in this area.

Towards the end of 1958 arrangements were made to obtain deer thyroids from both north-east and north-west Scotland. The values obtained from these two areas agreed very closely, but since more regular samples were obtained from the north-west, only the values for this area are shown (Fig. 1). Although the variability and standard error are higher for the deer measurements, due in most cases to small numbers in the samples, it would appear that the pattern for sheep and for deer is very similar.

During the period December 1958–January 1959, human thyroid glands obtained at post-mortem in the London area had a mean value of $1·45 \pm 0·37 \times 10^{-11}$ c./gm. (10 individuals), which is approximately 1 per cent of the value found in the lobes of sheep during this period. Since this occurred at a season of the year when fresh vegetables would be scarce, and milking cows would be fed mainly on stored fodder, it is suggestive, when compared with the stall-fed sheep experiment, that inhalation of iodine-131 by the lungs together with iodine-131 absorbed from drinking water represented in the adult human the major route of entry of iodine-131 during this period. The number of human thyroids sampled at any particular period was too small to obtain accurate information regarding how the iodine-131 content of the human thyroids was changing with time in relation to the iodine-131 content of the sheep thyroids.

Calculations of radiation dosage to the thyroids due to both β- and γ-emissions from iodine-131 have been made. These are based on a calculated radiation dosage of 11·2 rads per day per 1 μc. In the Aberdeen area during January 1–December 31, 1958, the calculated radiation dose to the thyroid glands of local sheep was 3·0 rads. During the period December 15, 1958–January 15, 1959, which is approximately six weeks after a series of twenty-nine atomic and hydrogen explosions in the northern hemisphere, the thyroid radiation dose due to iodine-131 has been calculated for sheep from north-east Scotland, deer from north-west Scotland and for humans from the London area. These values are:

Sheep	0·32 rad
Deer	0·31 rad
Human	$5·9 \times 10^{-3}$ rad

It must be emphasized that since the number of human thyroids sampled was small, the value calculated for the human cannot be taken as more than an approximation.

Sheep thyroid glands were collected in the Windscale area following the reactor incident on October 10, 1957. During the period October 26, 1957–March 13, 1958, thyroid glands were obtained from 77 sheep The first sample was from sheep killed on October 26, by which time the shorter lived isotopes of iodine would have decayed away Half-life determinations were done on the gamma-activity of the thyroids, the half-life being 8 1 days and the logarithmic decay curve linear with time A fairly wide scatter of values was obtained due to the sheep sampled coming from farms in different directions and distances from the Windscale pile

The highest values obtained were from four sheep killed on November 10, that is, 31 days after the release These animals had been obtained from two neighbouring farms situated 3,000 and 5,000 yd respectively south-south-east of Windscale This was within the area of maximum deposition[5] Their thyroids had a value of 2 0 ± 0 03 × 10^{-6} c iodine-131 per gm Further samples were obtained from this locality on November 27, 1 5 × 10^{-7} c per gm (2 animals), and on March 13, 1958, when a value of 2 2 ± 0 43 × 10^{-11} c per gm (14 animals) was obtained These three values gave a good fit to an exponential curve of half-life 7 3 days This compares with a mean half-life of 7 0 days (18 animals) obtained experimentally in this laboratory

An attempt has been made to obtain an approximate value for the radiation dose received by the thyroids of the sheep in the above locality Experiments carried out in this laboratory have shown that, following the administration of a single dose of iodine-131 to sheep, the maximum activity in their glands is attained at a mean of 3 7 days (20 animals) A value of four days has therefore been taken as the shortest time to reach maximum activity in the thyroids of the Windscale sheep This of course erroneously assumes that all the activity is washed off the pasture by rain after the first day Under ideal conditions, that is, when no activity is lost from the pasture other than by physical decay, the accumulation of iodine-131 in an animal would follow the equation

$$X = X_0 t \exp(-t)$$

where X is iodine-131 in the thyroid at time t; X_0 is iodine-131 originally deposited on the amount of fodder eaten in a day by an animal, decay constant of iodine-131, 0 0866

This equation gives a maximum value when $t = 12$ days A value of 12 days has therefore been taken as the longest time required to reach maximum activity in the thyroids of the Windscale sheep An exponential curve of half-life 7 3 days was drawn through the observed points and the radiation dose to the thyroid calculated over a period of three months following the release Assuming the time of peak activity of the glands to be four days after release, the radiation dose to the thyroid gland is approximately 4,500 rads, and assuming a peak activity at 12 days the dose is approximately 2,800 rads It is thought that a value between 3,000–4 500 rads represents a fair estimate of the radiation dose received by the thyroids of these animals It can be calculated from the activity of the sheep thyroids in the Aberdeen area over this three-month period that only 1 5 rads can be attributed to fall-out

Little information is available regarding the radiation dose required to produce abnormalities in sheep thyroid glands The experiments of Bustad *et al* [7] suggest that changes in thyroid activity occur following the administration of a radiation dose of 5,000 rads over a period of six months

This investigation was made possible by a grant to one of us (H A R) from the Medical Research Council We are indebted to Dr E E Pochin for obtaining the human thyroids, to N Craig for the Windscale sheep thyroids and to D J MacPherson and D M Dowell for the deer thyroids

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FORMATION OF DIFFERENT CELL–VIRUS RELATIONSHIPS IN TUMOUR CELLS INDUCED BY POLYOMA

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THE polyoma virus can induce tumours in mice, hamsters, rats and rabbits[1-4] With the development of a plaque assay for this virus[5], it has become possible to undertake quantitative studies on cell–virus relationships and to produce genetically pure lines of virus The use of such lines has shown that single-plaque isolates can induce multiple tumours in different species (ref 5 and unpublished work) An experimental system is thus available for the study of a variety of mammalian tumours induced by the same virus, and the present article is concerned with experiments that demonstrate the existence of strikingly different cell–virus relationships in different tumours induced by polyoma

The plaque assay, and hæmagglutination, were carried out as previously reported[5,6] The growth medium for cell cultures consisted of 0 5 per cent lactalbumin hydrolysate in Earle's saline and 20 per cent horse serum

In the first experiment, release of virus from seven mouse tumours induced in six mice (4 parotid tumours, 2 mammary adenomas and 1 kidney sarcoma) was determined by placing the cells in culture and testing the hæmagglutination titres of the culture fluid at various intervals For each tumour, 5 × 10^6 tumour cells dispersed in trypsin were plated in 50-mm Petri dishes with 4 ml of culture medium, and the entire medium was changed,

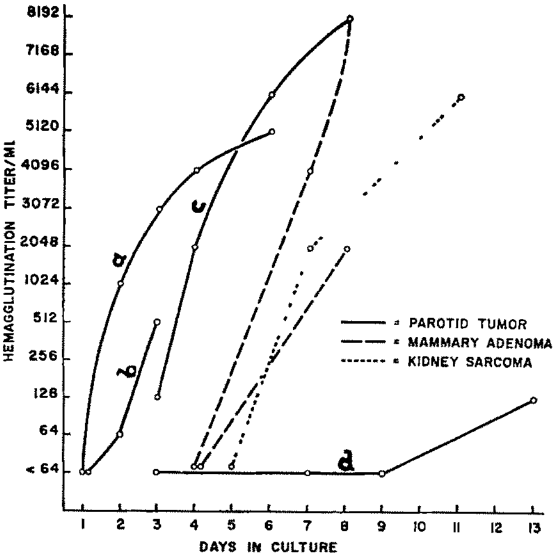

Fig 1 Release of virus from mouse tumour cells in culture The results are expressed as cumulative hæmagglutination titres per ml of tissue culture fluid, (*a*) *MP* 2, (*b*) *MP* 6, (*c*) *MP* 3, (*d*) *MP* 11

and tested for hæmagglutination titre, on the days shown as points on the curves (Fig 1) The titre obtained on a particular day has been added to the total of the previous titres, and the results are expressed as cumulative titres per millilitre of culture fluid Titres less than 64 per ml were not added to the cumulative results, since these were equivalent to the control value found for normal tissue culture fluid

The results (Fig 1) show that the release of virus in these cultures varies considerably even in different tumours of the same type The histology of the tumours and the appearance of the cells in culture make it unlikely that these differences in release of virus are merely due to possible differences in the proportion of normal cells in the various tumours

The results in Fig 1 also indicate that in all the mouse tumours tested there was a 'lag' period before high hæmagglutination titres were obtained from the cells in culture, and that the length of this 'lag' period varied in different tumours Since extracts of mouse tumours contain heat-labile inhibitors and high antibody titres[6], tests were made for the presence of inhibitors and antibodies during the 'lag' period These tests all gave negative results, so that differences in the 'lag' period may be due to difference in rates of synthesis of virus and/or release of virus

In order to determine the proportion of cells that release virus, cells from three parotid tumours, *MP* 10, *MP* 11 and *MP* 4, were plated on mouse embryo monolayers (*MP* 4 when plated alone gave hæmagglutination titres of 1,024–2,048 per ml a day, from the second day in culture, and *MP* 10 a titre of 512 ml during a three-day period from the second to the fifth day in culture) The proportion of cells releasing virus was determined by the relationship between the number of tumour cells plated and the number of plaques The results (Table 1) show that one of the factors in the difference in release of virus from cultures of these tumours can be a difference in the proportion of cells that release virus

Mouse tumours can thus release variable but considerable amounts of virus In a total of sixteen tumours tested, from fifteen mice, virus was obtained from every tumour This is not the case in tumours induced by polyoma in other species

Table 1 PROPORTION OF CELLS RELEASING VIRUS IN MOUSE PAROTID TUMOURS

Tumour	No of tumour cells seeded per plate	No of plates	Average No of plaques	Cells releasing virus
MP 4	125	5	101	1 in ~ 1
MP 10	400	2	98	1 in 4
	1,200	3	2	
MP 11	6,000	8	8	1 in 600–
	30,000	3	28	1 in 1,000

The sarcomas induced in hamsters, and the fibromas (that eventually regress) induced in rabbits, are hard tissues, and good cell suspensions have so far not been obtained from them Fourteen tumours from ten hamsters (7 subcutaneous sarcomas, 3 kidney sarcomas, and 4 heart sarcomas) have been tested for release of virus by placing minced pieces of tissue in Petri dishes either by themselves or on normal mouse embryo monolayers No hæmagglutination titres higher than the control value for normal tissue culture fluid were found in the fluid of any of these cultures after 13 days, and second-passage cultures of six of these tumours have also given no hæmagglutination titres after 14 days The fluids from eight tumours cultured for 13 days on mouse embryo monolayers were tested by the plaque assay, and of these seven gave no plaques, and one, a subcutaneous sarcoma, gave 180 plaque-forming units per ml during a release period of six days. In the fourteen hamster tumours tested there was thus no, or almost no, release of virus from the tumour cells The release of infectious virus is thus not necessary for the maintenance of malignancy

Two rabbit fibromas from two rabbits were studied by placing minced pieces of tumour on mouse embryo monolayers One tumour gave no hæmagglutination titre even after a second and a third passage of 14 days each The other tumour gave no hæmagglutination titre in the first passage of 14 days, and a titre of 64 after 11 days in the second passage. The virus isolated from this rabbit has produced tumours in hamsters

In rats, polyoma induces a high frequency of kidney sarcomas, especially after intracerebral inoculation[4], and these tumours give good cell suspensions by trypsinization As with mice, 5×10^6 tumour cells were seeded with 4 ml of medium, and the results for release of virus from four rat kidney sarcomas from four rats, cultured for periods ranging from 9 to 21 days, are shown in Table 2 No significant hæmagglutination titres were obtained in any of these cultures, and a plaque assay of the culture fluids has shown that at various times there was either no, or very low, release of virus In contrast to a titre of 2.8×10^6 plaque-forming units per ml. during a release period of 2 days obtained from mouse kidney sarcoma cells, the highest titre obtained from the rat kidney sarcoma cells was

Table 2 RELEASE OF VIRUS FROM RAT KIDNEY SARCOMA CELLS IN CULTURE

Tumour	Total plaque-forming units per ml	Release period (days)
RK 1	20	9
RK 2	160	13
RK 3	90	17
RK 4	640	21

6 × 10^2 plaque-forming units per ml. during a release period of 3 days. Tests for inhibitors and antibodies in the rat culture fluids (and in the fluids from hamsters and rabbits) all gave negative results. Virus isolated from the rat sarcomas has produced tumours in hamsters.

Rat sarcoma *RK* 2 was further tested by determining the numbers of plaques produced by tumour cells placed on mouse embryo monolayers (4 plates per cell dilution). No plaques were obtained even with an inoculum of 10,000 cells. Thus a very small proportion of cells in the rat tumours (less than 1 in 10,000 in *RK* 2) release virus. It should be mentioned that *in vitro* infection of normal monolayers has shown that in contrast to the high rate of virus multiplication in mouse tissues, there appears to be no, or very little, multiplication of the same virus stock in monolayers of hamster, rat and rabbit cells.

The above experiments show that a genetically homogeneous line of polyoma virus can induce the formation of various tumours with different rates of release of virus, and in some tumours no release at all. It is significant that both for the Rous sarcoma[7] and for the Shope papilloma virus[8] it has also been shown that it is possible to induce either tumours from which virus can be readily recovered or tumours from which little or no virus can be extracted. The possibility of virus induction from a pro-virus state, the existence of immunity to super-infection, and the behaviour of single-cell clones of tumour cells releasing virus and not releasing virus is being studied. For such investigations the polyoma virus provides an unusually favourable system, since a plaque assay for the virus has been developed (the existence of non-infectious incomplete particles can be determined by hæmagglutination), and tumour cells with widely different cell–virus relationships, can be readily and regularly established and studied in culture.

We are indebted to the Winfield Baird Foundation for a grant in support of this work.

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EXPERIMENTAL DEMONSTRATION OF AN INTERNAL RHYTHM OF REPRODUCTION IN A TRANS-EQUATORIAL MIGRANT (THE SHORT-TAILED SHEARWATER *PUFFINUS TENUIROSTRIS*)

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AND

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Commonwealth Scientific and Industrial Research,
Organization, Western Australia Regional Laboratory, University of Western Australia, Perth

THE trans-equatorial migration of the short-tailed shearwater or Australian 'mutton-bird' has been described and mapped by Serventy[1] (Fig. 1). Marshall and Serventy[2] further showed that the migratory flocks regularly leave their southern Australian breeding islands in April (autumn) at a time when their principal food—euphausian plankton—remains abundant, and when sea temperatures are still higher than at the November period of ovulation. It was concluded that the post-nuptial northern journey via Japan to the Aleutian and South Arctic contra-nuptial ('wintering') areas is probably in obedience to an inherent internal rhythm.

When the millions of birds first make their landfall at the breeding islands in the last week in September (spring) gametogenesis is already well advanced. The testes contain bunched spermatozoa. There is no doubt that both the spring sexual cycle and the southern journey are initiated under conditions of decreasing day-length while the birds are still north of the equator. However, the astonishing regularity of their Australian landfall and subsequent egg-laying (November 19–21 and the following 12 days) seemed to suggest that the nuptial journey must be 'timed' by some astronomical constant, possibly decreasing day-lengths. No obvious periodic changes that might operate as precise 'timing' factors were observed in the breeding area.

P. tenuirostris, in common with certain other long-distance migratory shearwaters, moults on the head and body shortly after egg-laying, but delays the replacement of its wing and tail quills until the completion of the exacting journey across the equator[3]. Like most other migrants the species lays down massive deposits of subcutaneous and peritoneal fat before migration.

The primary purpose of the present investigations was to try to determine whether decreasing day-length, or internal rhythm, controls the sexual cycle (and possibly, therefore, the migration). Secondly, it was desired to discover whether the peculiar moult rhythm would persist under varying stimuli. Thirdly, it was considered valuable to record the degree of fat deposition under such varying conditions in captivity.

A group of breeding adults was caught in the Furneaux group of islands in north-east Tasmania (lat. 40° 12′ S.) just before the beginning of the northward migration of 1957. They were sent by air to the Commonwealth Scientific and Industrial Research Organization Regional Laboratory at Perth, Western Australia (lat. 32° S.), and held in captivity for several months during the period they would normally spend in the North Pacific (see Fig. 1). It was found that after some initial losses those essentially plankton feeders could be maintained on a

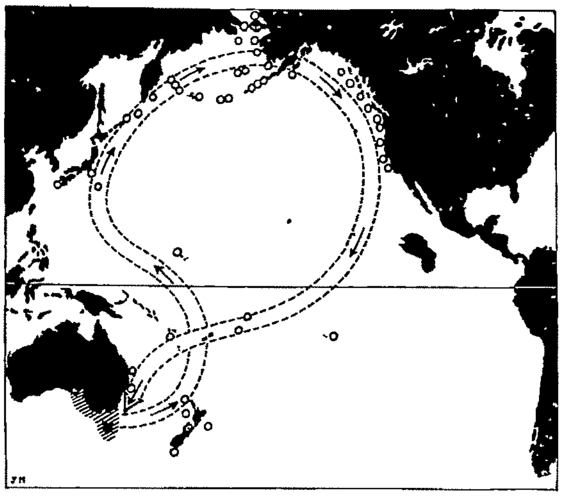

Fig 1 Generalized migration route of *Puffinus tenuirostris* The rings indicate localities of collected specimens Arrows indicate the direction of migration The breeding area is shown by means of parallel lines

diet of sliced fish Experiments were conducted during two successive years

Observations in 1957

The birds were divided into two groups of 15 individuals each The first lot was placed under a changing light regime approximating the day-lengths to which travelling wild migrants should be exposed, except that the total period was telescoped by half Thus, whereas the migrating flocks leave the breeding islands about mid-April and arrive back late in September, the artificial photo-periods in this experiment (successively equalling those of the equator, Japan, the Aleutians, the equator and finally the breeding localities) were so adjusted that the normal day-length of September 27 was reached on June 27

The second group of birds was held under natural Perth daylight (which is longer at the June solstice by about an hour than at the breeding islands used by the species but almost 10 hr shorter than at the Aleutians) Some of the birds from both cages were killed on June 27 The photostimulation experiment was then terminated and the survivors of both groups held in company, under ordinary Perth daylight, until September 29

(*a*) *Gonad condition on June* 27 Despite the striking differences in the light regimes of the two groups of birds, there was no detectable difference in their gonads Males of *both* groups showed some very slight advancement from the April condition and those that died during the first fortnight of the experiment Thus, the seminiferous tubules of some birds contained up to three rows of spermatogonia The diameter of ovarian oocytes in the single female killed was slightly greater than the April condition

(*b*) *Gonad condition on September* 29 Four birds survived to this date Of three males, one (originally from the photo-stimulated group) contained spermatozoa in some seminiferous tubules Of the other two males (originally from the natural day-length cage) one was even more advanced, having bunched spermatozoa The third male contained numerous primary spermatocytes in mitosis and a few secondary spermatocytes The overall size of gonad was slightly, but definitely, smaller than normal wild birds at the corresponding time A surviving female (originally from the photo-stimulated group) had the diameter of the largest oocyte measuring 3 1 mm , that is, within the range of normal wild birds at the time of land-fall

It was clear, then, that alteration of photoperiodicity, in the manner conducted in the experiment, had no great effect on the captive shearwaters The birds—both experimental and control—that were allowed to survive came rhythmically into a sexual condition only a little less advanced than that of the wild population by the date that the latter completed their trans-equatorial migration around the Pacific

Observations in 1958

The experiment was repeated with newly caught adults from the same breeding stations Again they were divided into two groups Half as before were kept under conditions of natural Perth daylight The other half were retained under a constant 12 hr illumination This is the day-length at the breeding islands about the time of the exodus migration This year birds were held until the period of normal landfall, when the survivors were killed and dissected on September 29 Three males and three females survived in the artificially lighted cage and seven males and two females in the natural light enclosure

Again there was no appreciable difference in the sexual condition between the birds in the two cages As before, all birds showed some gonad modification, and in some individuals testis development had almost, but not quite, reached the stage attained by normal wild birds at the corresponding time Four out of the ten males had produced spermatozoa, and the remainder contained primary and sometimes secondary spermatocytes The range of overall size reached that of the wild population, but the mean size was significantly below it Ovarian development was also slightly advanced and the largest diameters of oocytes (mean, 2 1 mm) were slightly inferior to them in normal birds at the corresponding stage

Wing and tail moult began in late June and July, but the moult was protracted and its completion retarded by comparison with that of wild birds Both groups of captives put on appreciable depot fat (corresponding to 'pre-migratory' fat) from mid-August onwards, reaching a maximum in early September The weight trends were identical in the two groups

In summary, these investigations show that in this migratory shearwater the breeding rhythm is persistent at least for one year after the animal is taken out of its normal environment and exposed to external influences (photo-period, temperature, food and habitat) exceedingly different from normal Although gametogenesis, wing moult, and pre-migratory fat deposition took place under these conditions at approximately the normal periods, there was nevertheless in some individuals a considerable asymmetry of the seminiferous tubules and a pronounced retardation of spermatogenesis that is never encountered in the wild population This suggests that internal events were tending to drift out of phase with the external environment and that essential (as yet undetermined) external influences, possibly including behaviour, were lacking

The experiments are continuing

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[1] Serventy, D L , Proc Seventh Pacific Sci Cong , 4, 394 (1956)

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FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, December 14

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W C 2), at 5 30 p m —Discussion on "Why Hi-Fi ?", opened by Mr P P Eckersley

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP (at 14 Belgrave Square, London, S W 1), at 5 30 p m —Mr P B Cornwell 'Insect Control by Gamma Irradiation"

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S W 7), at 8 30 p m —Baron G de Gerlache de Gomery "The Belgian Antarctic Expedition"

Tuesday, December 15

INSTITUTE OF MARINE ENGINEERS (at the Memorial Building, 76 Mark Lane, London, E C 3), at 5 30 p m —Mr K Maddocks "Some Aspects of Marine Reactor Security"

INSTITUTE OF PHYSICS (at 47 Belgrave Square, London, S W 1), at 5 30 p m —Mr K G Freeman "Tubes for Colour Television"

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (at Savoy Place, London, W C 2), at 5 30 p m —Discussion on 'Data Handling Problems in Atomic Installations", opened by Dr D Taylor

Wednesday, December 16

POWDER METALLURGY JOINT GROUP OF THE IRON AND STEEL INSTITUTE AND THE INSTITUTE OF METALS (in the Hoare Memorial Hall, Church House, Great Smith Street, London, S W 1), at 9 30 a m —Symposium on 'The Powder Metallurgy of Magnetic Materials'

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W 1), at 5 p m —Prof P B Ackermann and Prof F Walker "Vitrification of Arkose by Dolerite near Heilbron, Orange Free State"

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S W 7), at 5 p m —Dr H Wexler "Seasonal and other Temperature Changes in the Antarctic Atmosphere", Mr W Hitschfeld "Patterns of Hailstorms in Alberta"

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 5 15 p m —Sir Hugh Beaver, K B E "Statistics as a Tool of Management" (Presidential Address)

INSTITUTE OF PETROLEUM (at 61 New Cavendish Street, London, W 1), at 5 30 p m —Mr A C Hartley "Pipelines'

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S W 1), at 6 p m —Dr S G Hooker "The Future of Air Breathing Engines in Aviation" (James Clayton Lecture)

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at 14 Belgrave Square, London, S W 1), at 6 p m —Discussion of Research Papers recently published by Members of the Group

SOCIETY FOR ANALYTICAL CHEMISTRY, MICROCHEMISTRY GROUP (at "The Feathers", Tudor Street, London, E C 5), at 6 30 p m —Discussion on "Applications of the Flask Combustion" opened by Miss M Corner and Mr C B Dennis

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W 1), at 7 p m —Mr J F Coales "Random Inputs and Load Variations"

Thursday, December 17

BRITISH COMPUTER SOCIETY, LONDON BRANCH (at the Northampton College of Advanced Technology, St John Street, London, E C 1), at 2 30 p m —Discussion on "Conversion between Analogue and Digital Representation"

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at 14 Belgrave Square, London, S W 1), at 2 30 p m and 5 30 p m —Scientific Papers

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Dr A J Robinson 'Relationship Between Particle Size and Collector Concentration" Mr D Borchers "Deepening of No 1 Vertical Shaft at Premier (Transvaal) Diamond Mining Co , Ltd "

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W 1) at 5 p m —Prof E V Schenkman "Supersolvable Groups"

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W C 2), at 6 p m —Discussion on 'The Presentation of the History and Philosophy of Science", opened by Prof H Dingle

Thursday, December 17—Friday, December 18

PHYSICAL SOCIETY (in the Townsend Lecture Theatre, The Clarendon Laboratory, Oxford), at 10 a m daily—Conference on "Electron-Phonon Interaction in Solids"

Friday, December 18

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at 14 Belgrave Square, London, S W 1), at 6 30 p m —Dr F E Camps "Some Aspects of Forensic Science"

Friday, December 18—Saturday, December 19

BRITISH PSYCHOLOGICAL SOCIETY (at University College Gower Street, London, W C 1) Conference

Saturday, December 19

BIOCHEMICAL SOCIETY (in the Department of Chemical Pathology, King's College Hospital Medical School, Denmark Hill, London, S E 5), at 10 30 a m —389th Meeting

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

KNOOP RESEARCH FELLOW (graduate in medicine or science), to work on cerebral enzymatic aspects and on the presence of chemical abnormalities in hereditary degenerative cerebral conditions—The Secretary, Institute of Neurology, The National Hospital, Queen Square, London, W C 1 (December 18)

LECTURER or ASSISTANT LECTURER IN GEOGRAPHY at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (December 30)

ASSISTANT LECTURER or LECTURER IN PURE MATHEMATICS, and an ASSISTANT LECTURER or LECTURER IN MATHEMATICAL STATISTICS —The Secretary, The University, Exeter (December 31)

LECTURER (preferably with an interest in the theory of machines, mechanical servomechanisms or the strength of materials) IN MECHANICAL ENGINEERING—The Secretary, The Queen's University, Belfast (January 1)

PROFESSOR OF APPLIED MATHEMATICS—The Secretary and Registrar, University College of North Wales, Bangor, North Wales (January 1)

LECTURER or ASSISTANT LECTURER IN CHEMISTRY at the University of Malaya (Singapore Division)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (January 15)

ASSISTANT LECTURER IN STATISTICS, to teach theoretical statistics and some mathematics—The Secretary, The London School of Economics and Political Science, Houghton Street, Aldwych, London, W C 2 (January 22)

ASSISTANT (preferably with some knowledge of horticulture and experience in proof correcting and indexing) TO THE EDITOR—The Secretary, The Royal Horticultural Society, Vincent Square, London, S W 1, marking envelope "Confidential"

CHEMIST or AGRICULTURAL CHEMIST (with an honours degree in science or equivalent qualification, and preferably postgraduate research experience to Ph D level and a knowledge of agriculture) to undertake research on the quality of protein in animal feeding stuffs for non-ruminants—The Secretary, The Rowett Research Institute, Bucksburn, Aberdeen

CHEMIST or BIOCHEMIST, for research in the steroid field—The Director, Group for Research on the Chemical Pathology of Steroids, Jessop Hospital for Women, Sheffield 3

LECTURER (honours graduate in mathematics or mathematical physics) IN THE DEPARTMENT OF MATHEMATICS (including Industrial Statistics and Computing)—The Registrar, College of Technology and Commerce, Leicester

PHYSICIST (with research experience to Ph D standard in infra-red spectroscopy), to undertake a programme of investigations in atmospheric radiation—Imperial College, Department of Meteorology, London, S W 7

RESEARCH ASSISTANT (with a good mathematical background including statistical analysis, and preferably some knowledge of the field of metal fatigue) IN THE DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS, to undertake work on the theory of cumulative damage in fatigue—The Secretary and Registrar, The University, Southampton

SENIOR TECHNICIAN or TECHNICIAN IN THE DEPARTMENT OF GEOLOGY—The Bursar, The University, Sheffield 10

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Other Countries

Pacific Insects, Vol 1, No 1 (July 15, 1959) Pp 172 (Organ of the Program "Zoogeography and Evolution of Pacific Insects ") Subscription rates, per volume (4 issues totalling at least 400 pages) Japan Y 1,700 , N America 5 Dollars , 35*s* 6*d* Single issues Y 600 , 2 dollars , 13*s* (Honolulu, Hawaii Entomology Department, Bernice P Bishop Museum 1959) [2210

Inter-American Tropical Tuna Commission Annual Report for the year 1958 Pp 121 (La Jolla, Calif Inter-American Tropical Tuna Commission, 1959) [2210

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FUTURE OF BROADCASTING AND TELEVISION

THERE are few more important questions for mankind to-day than that of the creative use of the mass media, and recent evidence of the abuse or wasteful use of television or of broadcasting only accentuates the urgency of determined efforts to discover effective ways of using the immense powers of these media over the minds of men and women and young people for creative and positive purposes. The urgency of this problem was well indicated by Alderman F. J. Stott, of Plymouth, speaking on the public library as a major instrument of education, in an address to the Library Association at its annual conference in September. Alderman Stott stressed indeed rather the threat to the balanced development of the individual members of our society under present conditions, and it was Prof. L. Hogben who referred to the immense positive possibilities of the wise and imaginative use of both sound broadcasting and television in solving some of our current educational problems, especially those arising out of the shortage of teachers.

It was accordingly a timely and public-spirited act on the part of *The Twentieth Century* to devote the whole of its November issue to the subject of television in Great Britain, with the declared object of elucidating ways in which television could be put to creative use. Comparatively few constructive suggestions emerge, in fact, from a series of highly interesting articles, among which those of Dr. J. Trenaman, Mr. Gordon McLachlan and Mr. Ed Murrow stand out; but the articles certainly illumine the main issues which are urgent to-day. That is also true of Mr. Norman Collins's discussion of "Minorities and Monopolies", but his article appears to have been provoked by Mr. H. Carleton Greene's address to an association of German business men on the threats which political and commercial control offer to broadcasting: provoked almost to the point of obsession, Mr. Collins is betrayed into too many loose and dubious assertions.

Not the least valuable contribution, however, is the introductory editorial note, which makes an important point that, as is duly noted, the British Broadcasting Corporation itself cannot urge: while the B.B.C. for many years has been changing its approach and no longer seeks to impose what it thinks good, appreciating that there is a much wider range of good things than it once believed and offering to share them with those who want them, it has, in its turn, set standards of balance and taste to which commercial television has had, in part, to conform. Nevertheless, while the Corporation's task is to provide a balanced output of opinion, information and entertainment, and to cater for important minorities as well as the majority, there is a large public which looks to television solely for light entertainment. A serious programme accordingly loses for the B.B.C. much of its audience if its rival is showing something lighter; and if the B.B.C. lost its mass audience, if it was content merely to cater for the serious minority, viewers would ultimately resent paying for a service that was not catering for them.

This situation may well account for whatever confusion or hesitancy may seem to characterize B.B.C. policy; but no Government would stand out against public feeling or could be trusted to subsidize the B.B.C. from general government funds, and for that reason it is suggested that the B.B.C. needs now an additional channel so that it can cater for minority and majority interests throughout the entire broadcasting day. In its latest annual report the Corporation again pleads for a third television channel to be under the control of the Corporation, and claims that two B.B.C. television services could be so planned that the viewer always had a choice at any time of the evening between lighter and more substantial fare. While it can be fairly claimed that in 1958–59 the B.B.C. in such relatively serious but lively television programmes as "Panorama" and "To-night" has set a standard that can do much to enhance man's understanding of the world and his enjoyment of it, there is substance in the argument that a third television network should be allocated neither to the B.B.C. nor to the Independent Television Authority, but to a number of regional corporations, the controllers of which have no direct financial stake in the size of their audiences and who should seek to represent the people of their regions.

Mr. McLachlan's article, "The Gold Mine of Commercial Television", displays fairly enough the issues raised in commercial television and the nature of the choice that will confront the nation when the financial arrangements fall due for revision within the next five years. Mr. McLachlan suggests that the Committee of Public Accounts, in its third report for the session 1958–59, foreshadows radical proposals from the policy makers of both main political parties. He is a little uneasy as to the extent to which the public interest is likely to be served, but he sees signs that the profit motive has already lost something of its dominance and has been replaced by that of prestige, which should certainly be more sensitive to damage by abuse.

The difficulty in dealing with commercial television is not that it is concerned primarily with making profits, but the kind of popularity to which the making of those profits is geared. It may be unfair to suggest that the British Broadcasting Corporation is better than the Independent Television Authority because it does not have to make a profit; but it, too, is inhibited from frightening or jolting its audience. It shirks fundamental controversy and when it speaks for Britain its voice must generally be the voice of a broad consensus When Mr Collins claims that the fears of most of those who opposed the setting up of an alternative Independent Television system have proved groundless, it is difficult to take him seriously, and, for all his fierce opposition to Mr Carleton Greene's wish to exclude business as well as political interests from any say, direct or indirect, in the control of broadcasting, he completely fails to show that the Independent Television system is in any true sense a public service system, or that it expresses any more fully than the B B C the nation's activities as a whole

To be aware of such dangers is one thing, to determine how best to avoid them is quite another, and for positive suggestions one must turn rather to Dr Trenaman's survey of the effects of television, to Prof Asa Brigg's article, "The Image and the Voice", to Mr M Richardson's "Best and Worst of Inventions", or to a paper read by Dr W Belson at the British Association meeting at York Prof Briggs shows, for example, how much is now being done to put television in its correct place in society and in relation to the other mass media Accurate assessment here is essential if television and sound broadcasting are to be used constructively and to the greatest advantage That is why Dr Belson's work on the effects of television upon the interests and initiative of adult viewers is important

In his paper at York, Dr Belson, from studies on B B C television, showed that television reduces the frequency of occurrence of viewers' acts of initiative and also their interests in terms both of strength of identification and level of activity Both in initiative and in interests the loss is at first substantial, but thereafter a recovery sets in which is almost complete after about five years For a good time to come the total loss to the community is likely to be substantial, but there are exceptions, and Dr Belson suggests that study of these exceptions may be rewarding both from a cultural and a commercial point of view

The importance of free experiment at this stage in order to discover the full potential contribution which television may be able to make to culture, to education and to social welfare in any true sense can scarcely be over-stressed, and any decisions taken in the next five years should be such as to ensure that those to whom television—and also sound broadcasting—is entrusted are given full freedom to experiment and ample resources to do so No sectional interest should be permitted to occupy a position which could frustrate or distort such developments, and once again the critical importance of the third network should be apparent Any changes or new arrangements should be such as to secure as far as is humanly possible the dominance of the public interest and the conception of public service

Perhaps the outstanding feature of this symposium of articles on television is the evidence it provides both of the immense financial interests at stake and of the little that is yet known regarding the constructive use of television Dr Trenaman directs attention, for example, to the premature assumption that television can communicate ideas to a much larger public than other media, and to the fact that the measured social effects of television are a good deal less spectacular than one might suppose Nevertheless, they can be serious enough We cannot altogether discount the tendency to insulate the viewer from the realities of the world in which we live, which Mr Ed Murrow finds so alarming a feature of the American system, and if Dr Trenaman can point to numerous lines of profitable investigation, there is also much work still to be done on the technique of using television and indeed sound broadcasting, some of which could well lead to results demanding some curb on the manner in which advertising is conducted at present

This work should not be left solely to the universities or to independent foundations, such as the Nuffield Foundation As Mr Richardson points out, both a lead and support could and should be given by the Government in order to enable the educational potentialities, for example, to be realized and some order established The work already carried out by Dr Trenaman has established beyond question the supreme importance of education here Ultimately, the use that is made of television or sound broadcasting depends on the standards of education of the mass of the population, and that must not be forgotten in considering what contribution the new mass media can make to the removal of difficulties arising out of particular current—if possibly temporary—problems such as the shortage of teachers of science But if we are to use television and broadcasting wisely and effectively, either politically or culturally, as a means towards education we must know a great deal more about how to convey ideas and about the interactions of sound broadcasting, television and the other mass media—their limitations as well as their potentialities

There is, however, one aspect of the work of the British Broadcasting Corporation which is virtually ignored in the symposium published in *The Twentieth Century*, and yet it is the one where the loss of the Corporation's monopoly and its restriction to one television channel could have the most serious effects, even if the Government's new policy in regard to overseas information services may now remove the danger of financial stringency It could be questioned whether the external services of the Corporation could maintain its deservedly high reputation for objective and honest reporting of news if, for any reason whatever, the Corporation as a whole lost or impaired its reputation for telling the truth That is just what could follow if the particularly close co-operation and interrelation between the Government and the Corporation were once disturbed, either in respect of the external services or of other services

That relation is, of course, based on mutual good will and respect, and both sides—the Government and the Corporation—have a vested interest, as Mr James Monahan recently emphasized, in keeping viable the relation between the "editorially responsible External Services" and the co-operative, financially responsible "prescribing departments" Clearly the system seems to work, and to produce the genuine "voice of Britain", and it is well to pause before agreeing on any changes in the relations between the British Broadcasting Corporation and the Government which might jeopardize such an asset Objective reporting and editorial independence from the Government are not easily retrieved once sacrificed, and though the Overseas Services are only beginning to use television, too much care can scarcely be taken to avoid damaging such precious assets, or placing new obstacles in the way of their utilization, when shaping the conditions or the techniques under which the new and different powers of television are to be used Once the fairness and impartiality of a broadcasting system becomes suspect its authority as a source of information is destroyed, and quite apart from any short-term or long-term effects which either sound broadcasting or television may have on its constant listeners and viewers, Mr Carleton Greene's warning is endorsed by all that has happened in the broadcasting field since his lecture was given last April.

REVIEWS

SCIENCE WRITING

The Technical Writer

An Aid to the Presentation and Production of Technical Literature By J W Godfrey and G Parr Pp 340 (London Chapman and Hall, Ltd, 1959) 45*s* net

WHAT exactly Ecclesiastes would have said about the making of books about the making of books—among Charles Lamb's *biblia abiblia*—we cannot know, but so shrewd an observer would surely have noticed that there seems nowadays to appear a steady stream of books about the writing, typing, editing, printing and publishing of scientific material But perhaps the book to end books of this kind is the one before me, which probably deals more extensively than any other in English, on either side of the Atlantic, with every stage in the production of scientific and technological printed documents, from papers and pamphlets to text-books and encyclopædias

It is implicit in the authors' undertaking that good must come of the writer's knowing something about the procedures that are the responsibilities of the compositor and the 'Reader of the Press', who are going, respectively, to set his manuscript in print and to correct its first proofs What is not so certain is whether the authors also think that it would be good for the latter two craftsmen to know something about the first one's problems For the most part, those at the publishing end of the chain have to gather piece-meal all they need to know about the scientist's literary habits—if anything so varying and variable can be described as a habit This book will certainly make the task easier, in spite of the fact that it seems primarily intended for the instruction of those engaged in the pre-printing part of producing "Technical Literature"

This, the comprehensive if somewhat vague title of the book's first chapter, is there defined more precisely, and it becomes evident, as is stated by the authors and seems inevitable from their own technical backgrounds, that there is a bias towards engineering and allied subjects, including physics, in the illustrative examples they have chosen This in no way detracts from the value of the book for those practising other disciplines, and for two reasons first, there are many problems of presentation common to all scientific disciplines and their technologies, secondly, the call for neatness and exactness in both text and illustrations is probably greater in physics and its applications than in any other scientific field, so that the methods used to achieve them may be studied with advantage by those who are not engineers

Chapters 2 and 3 deal, respectively, with "The Technique of Technical Writing" and with "Style and Presentation" In some ways they are the least satisfactory chapters in this immensely well-informed useful book, if only because they take insufficiently into account, again perhaps because of the general bias towards physics and its technological offspring, the great variety of journals spread over half a dozen or so major sciences and their numerous applications, with a bewildering mass of differences in conventions and 'house rules' Moreover, I have an uneasy feeling that the authors, who in general write lucidly and economically, are possibly not the best mentors on the writing of English My suspicions about this matter were first aroused by the fact that they recommend, and rightly so, Fowler's "Modern English Usage" as one of the books always to be consulted, and so presumably to be followed, by the scientific writer, yet seem themselves unable to adopt, or to be unaware of, Fowler's still valid distinctions between 'which' and 'that' as relative pronouns

From Chapter 4 ("Illustrating the Text") on the book becomes increasingly concerned with mechanical rather than with intellectual processes, so that Chapters 5, 6, 8 and 9 describe, in that order, "Printing Processes", "Setting Out the Text", "Typography for Technical Publications" and "Set-up of a Technical Publications Unit" Intermediate in concern with hand and brain are Chapters 7 and 10, which deal with "Editorial Procedure" and with "Technical Authorship", the latter phrase is not particularly illuminating, but the chapter covers an attractive medley of often apparently trivial matters, though they occasionally may assume frighteningly large proportions, such as the preface, the 'blurb', indexing, copyright, defamation, translation The book ends with four useful appendixes (wrongly called 'appendices' by the authors, who in this matter follow the bad example set by some official publications)

In one appendix the authors rightly insist on the duty of all writers (and they might perhaps have added of all editors too) to stick to the British Standard 1219, from which they quote substantial portions, when correcting proofs In subsequent editions they will doubtless direct attention also to the British Standard 2509 (Periodicals of Reference Value Form and Presentation), which has become available since their book was first published What

I should have liked, however, is rather more emphasis on two additional essentials

First of all, long before the proof-reading stage is reached, the correct conventions should be followed when indicating on the manuscript (which must be typewritten) how and where particular words and phrases are to be set in print Thus nothing is more infuriating to an editor (or misleading to a compositor) than use of the single underline to indicate, for example in the list of 'references', both the setting of journal names (or their abbreviations) in italics and the setting of volume numbers in 'bold' type , and this leads me to the second 'must'

The authors of scientific papers—and it applies to them much more than to pamphlets and books and other non-periodical publications—are under both a practical and a moral obligation to study meticulously, and having studied to follow just as meticulously, the exact conventions observed in the journals to which they intend submitting manuscripts In such matters as the use of italics, already referred to in a slightly different connexion, or of 'full-stops' after abbreviations and captions, the particular system of references used (as distinguished by the authors on pp 95 *et seq*) and the arranging of headings and side-headings, previously published papers in each individual journal must be examined The method and place of inserting tables and illustrations, and also of their legends, and in particular how much, if anything, is to be put on graphs besides points and lines, are almost always covered by the "Instructions to Authors" issued by or in many journals

There are two reasons why the author of a paper should take all possible trouble to reduce to a minimum the need for editorial amendment of his manuscript First, he will thereby establish some degree of confidence towards himself not only from the editor but also from any assistant editors or referees to whom his draft is submitted , a reputation for scrupulousness in the preparation of manuscripts for the press cannot harm and may enhance the author's reputation for general reliability, even in his own field of science Misdemeanours in these matters are, by that same token, seldom forgotten

The second reason is simply good manners Many editors and referees acting for scientific and technological journals, especially those that primarily cover the basic sciences and are published by learned societies, work in a purely honorary capacity, being already fully employed in research, teaching or administrative jobs undertaking their additional tasks as labours of love Anyone who, through carelessness or laziness, increases their work unnecessarily—and indeed this is also true, *mutatis mutandis*, for the paid editor—is simply guilty of gross discourtesy to a scientific colleague The matter is one neither of science nor of English, but just of professional courtesy

"The Technical Writer" will undoubtedly help to smooth the path between the taking of scientific or technological action and its description in print It must be on the library shelves in every department of every institution in which individuals prepare papers for publication in scientific, technological and technical journals Some senior members of such institutions, especially if they are involved in producing books as well as papers, might with advantage possess their own copies For editors and referees and their associates on editorial boards and publication committees, possession of this book is obligatory Above all, when the young and the not-so-young author is putting the final touches to his draft before submitting it for publication, let him think of the editor, whose editorial duties are so well made clear in this book, and remember that there, but for the grace of God, may he one day go—and act accordingly

A L BACHARACH

NEWTONIAN DOCUMENTS

Isaac Newton's Papers and Letters on Natural Philosophy and Related Documents

Edited with a General Introduction by I Bernard Cohen Assisted by Robert E Schofield Pp xiii + 501 (Cambridge At the University Press, 1958) 70*s* net

THE study of the history of science is still seriously hampered not only by the lack of enough good secondary works but also by the unavailability of major sources Fortunately as regards the study of Newton the situation is improving an English translation of the "Principia" is in print, and a *variorum* edition promised , the "Opticks", with adequate introductory material, has been reprinted recently , the Royal Society edition of Newton's correspondence is eagerly awaited , and a Leverhulme award has been made for the study of Newton's mathematical papers

The present work is a further important contribution in this field It "brings together for the first time Newton's scattered papers and letters on natural philosophy (excluding mathematics, pure theology, and biblical chronology) as they were actually available *in print* during most of the 18th century" Apart from the "Principia", the "Opticks" and the comparatively uninfluential "Optical Lectures", the papers reprinted in this volume represent "the complete corpus of Newton's writings on physical science that actually influenced the scientists and thinking men of the 'Age of Newton' "

The first group of scientific papers comprises Newton's "New Theory about Light and Colors" and the documents of the controversy to which this gave rise, together with his second paper on the subject (read to the Royal Society during 1675–76 but not published until 1757) and his papers on the improvement of the telescope In all, these account for nearly half the book It is of the greatest convenience to have the objections raised against Newton's theory and his replies collected together in a single volume , and the reader will have sympathy with Newton's later remark to Leibniz, "I was so persecuted with discussions arising from the publication of my theory of light, that I blamed my own imprudence for parting with so substantial a blessing as my quiet to run after a shadow" T S Kuhn's twenty-page introduction to this section will greatly help the reader to thread his way through the controversy, even if he feels at times that Mr Kuhn is perhaps too critical of Newton But there is no doubt that Newton brought many of the troubles on himself by leaving his original exposition seriously incomplete

The remaining papers form a miscellaneous collection on chemistry, atomism, the aether, and heat, and there is a short introduction by Marie Boas. There then follow letters from Newton to Bentley "containing some arguments in proof of a deity", with the famous passage in which Newton asks

Bentley not to ascribe to him the notion of gravity as "essential and inherent to matter"; Bentley's lectures on "a confutation of atheism from the origin and frame of the world"; Halley's review of the "Principia" and the account of Newton's work which he wrote for presentation to King James; the first biography of Newton, Fontenelle's "Éloge"; and, as an appendix, an index to the references to Newton in Birch's "History of the Royal Society".

Apart from the general introduction by I. B. Cohen, the introductions to the various sections, and the appendix, the whole of this volume is already available to scholars with access to a good library. Those who are not so fortunate will benefit most from the book; and teachers of the history of science will at last be able to give their students an opportunity to study Newton's mind at work. But one may perhaps question whether the best methods have been adopted. In every case the papers and letters are reproduced facsimile. Obviously one must have the original diagrams reproduced facsimile, if only because their shortcomings led to misunderstandings; equally obviously, if one is to study the impact of Newton on the eighteenth century, one must read him in the sources available in the eighteenth century. But does one need to work with the type then used, and to correct the misprints oneself? Some papers are printed first in Latin and then—for some reason still facsimile—in a nineteenth-century translation. On the other hand, Fontenelle's "Éloge" is given only in English, although Gillispie in his introduction says the translation "is frequently clumsy and nowhere better than adequate". It is difficult to understand why the whole was not reset in modern type, with misprints corrected and with footnotes giving at least the pages for reference back. But this is to say only that a very useful book might have been better.

M. A. Hoskin

A RELIGION OF MAN?

Concerning Human Understanding

Essays on the Common-sense Background of Philosophy. By Prof. Nikunja Vihari Banerjee. Pp. 333. (London: George Allen and Unwin, Ltd., 1958.) 30s. net.

PROF. N. V. BANERJEE, in his recently published book entitled "Concerning Human Understanding", has in fact made a collection of a number of his essays which were written over a period of twenty years.

The title is slightly misleading as the essays of Banerjee are concerned primarily not with the theory of knowledge or understanding but rather with a quest for a religion which will unite (in a sense) the conflicting values of oriental and occidental cultures.

These culminate in a final essay (Part 4. 5) which is in fact a strong recommendation to the world of "the principle of love and kindness in the will of man, and in the world of human affairs, in order that power, and law and institutions, instead of having to exercise relentless authority and despotic rule over man, may be dedicated to the cause of humanity and consequently the world that is to sustain man from the cradle to the grave may become as good as possible and really human. And this suggests the remedy for the crisis of civilization which seems to have reached its climax in our day" (p. 324).

Prof. Banerjee takes Jesus as the supreme example of a dedicated life, such as he advocates. Banerjee has the advantage of being well acquainted with both the chief "Eastern" religious cults and with Christianity in its "Western" expression.

He is severely critical of what he calls "the latest phase of human civilization", in particular of the contrast between the extending achievements of natural science, on one hand, and, on the other, the activity of "political organizations, headed by the State", which are apt to determine man's present as well as his future, and which, according to Banerjee, are approaching Nature in what he calls its irrational and inhuman quality. It is in this context that Banerjee writes with most emphasis of "the failure of civilization".

He writes that man is hostile to and divided against himself in an unprecedented way. Nature is also hostile to man, but this is inevitable, while man's hostility to himself is suicidal.

In what he claims is a historical retrospect, Prof. Banerjee contrasts "the religion of God or gods", for which religion Nature is an object of *fear* (my italics), with what he calls "the religion of man".

To overcome the fear of Nature, Banerjee contends, is not enough. Mankind needs to keep his awareness of the hostility of Nature as a kind of stimulus (p. 325).

"The remedy" is approaching. It increases peace with Nature (*loc. cit.*). Here again the Eastern and Western mind are contrasted. Western civilization tends to distract the attention of man from what is wrong in himself, while on the other hand, oriental civilization is conspicuously introspective. Hence, according to Banerjee "the developed eastern mind" is more aware of the problem of liberation.

This book is readable and challenging, but it is doubtful whether the author succeeds in providing sufficient evidence for his sweeping generalizations, for example, about theories of knowledge (Parts 1 and 2), and about philosophy generally, including the theory of value (Part 3). It is also regrettably doubtful whether or not he succeeds in making plausible the more optimistic parts of his book, that is to say, those in which he appears to recommend a confident expectation of the reconciliation of all the opposed tendencies (for example, between Eastern and Western thought) which he clearly and eloquently describes.

D. J. McCracken

HUSSERLIANA COMPLETED

Edmund Husserl

Erste Philosophie (1923/24). Zweiter Teil: Theorie der Phänomenologischen Reduktion. Herausgegeben von Rudolf Boehm. (Husserliana, Band 8.) Pp. xliii+594. (The Hague: Martinus Nijhoff, 1959.) 26.75 guilders, paper bound; 32 guilders, cloth bound.

WITH the appearance of this part, the plan to issue eight volumes of the works of the great master of phenomenology has reached fruition. The Husserl-Archiv at Louvain has erected as enduring a monument to his memory as can be imagined. Scholars in this field are thus obliged to study such a pre-suppositionless philosophy to the limit of their powers, not only for its own sake but in due recognition of its place as a basis for all knowledge. Whether the emphasis is mathematical or psychological, or anything in between, the need is for rigour and the re-establishment of an acceptable first philosophy (re-establishment because the necessity was clear enough to Aristotle; then as now, there will always be links with theology whether seen overtly or not). The passage of some twenty-three centuries has but underlined mankind's urge to re-discover metaphysics (as first knowledge), not merely as a matter of professional controversy but as an essential stance for human thought in every sphere.

Before going further, a cordial tribute is fully due to the editor of this member of the series (and of No. 7 also), Dr. Rudolf Boehm, for the immense labour which he has expended upon his task. I was privileged to catch a glimpse of the work in progress at Louvain, and to participate for an hour or two in discussion. Perhaps nowhere else in the world to-day can epistemology be better experienced than in that upper room furnished in the Cardinal Mercier Place.

The book now before us is the second part of Husserl's "Erste Philosophie" (1923–24), that is, that concerned with the theory of phenomenological reduction. It consists of four main sections with an editorial introduction, together with a number of supplementary passages, and an appendix. The core is the assemblage of lectures 28–54 inclusive which, with numbers 1–27 (Volume 7), were delivered by Husserl before the University of Freiburg-im-Breisgau. Section I deals with preliminary mediations upon the apodeictic beginning of philosophy. Section II provides a *critique* of experience, the first approach to transcendental reduction. Section III discusses the phenomenology of this process, the second approach to phenomenological reduction. Section IV brings together phenomenological psychology, transcendental philosophy and phenomenological philosophy.

Since the central theme presents with the utmost rigour the universal question of the possibility of 'knowing' the world around us in terms of a proper relationship between objective time and subjective time-consciousness, it is well to recollect the three kinds of knowledge commonly accepted by scholars. Thus, apodeictic knowledge is the knowledge of something which must occur, assertoric knowledge is the knowledge of what is actually happening, whereas problematic knowledge refers to the knowledge of what might occur, or at least, be capable of occurring. Much of Husserl's outlook is, technically, problematical: it is here that his work touches the domain of discovery as if to say 'so and so is possible'.

The value of this for natural science lies perhaps in the augmented part played by probabilities in modern physics. The whole focus of phenomenological reduction is upon not merely the possibility but the necessity of avoiding immediate judgment over a wide field of human cognition. Formally, this is likely to remain inevitable, but in the applied sciences it may look like an insidious form of escapism. Such a view—if it exists—would seem to be mistaken; the whole of technology approximates to one great exercise, or worked example (however important and ingenious), rather than to the deliberate contemplation of fundamentals. It is not the fault of this ceaseless striving for a pre-suppositionless discipline that physics tends, in matters philosophical, to look after itself. But, on the other hand, natural science has fed back quite a few basic problems for the consideration of 'first philosophers'.

A peculiarity of this noble work, which is assessed as a major contribution to the humanities, is that it implies, to a considerable extent, self-immolation, and that not once, but twice. The first instance is that the very idea of transcendental phenomenology, so highly valued by Husserl, appears to have suffered an almost complete dissolution in this attainment of the notion of a contemporary first philosophy. The second abandonment is that of the Cartesian way as we find it in the *Ideen* and the *Méditations Cartésiennes*. Maybe this is not the one and only road to "Philosophie als strenge Wissenschaft", to which ideal Husserl remained completely loyal. It is characteristic of a mind of the first order that it can face the obliteration of the lesser by the greater without flinching, while at the same time offering us a new chapter in epistemology comparable perhaps with the advent of Descartes and all that followed it.

F. I. G. RAWLINS

SUBSTANCE AND SHADOW

The Prof

A Personal Memoir of Lord Cherwell. By Sir Roy Harrod. Pp. xv+282+4 plates. (London: Macmillan and Co., Ltd., 1959.) 25s. net.

LORD CHERWELL'S complex life is a challenge to biography. Probably no Englishman since Francis Bacon has combined such a deep interest in natural science with so high a public office; and Cherwell's contemporaries may well be as divided in their approbation as were those of Bacon. A biography of Lord Cherwell, taking all aspects fairly into account, must therefore be a most interesting book. Lord Birkenhead has been asked to write it.

In the meantime, Sir Roy Harrod has produced a personal memoir based on more than thirty years close acquaintance with the 'Prof'. As the author realizes, the book is at least as informative about himself as it is about his subject; this review will deal only with the new light that is thrown on Lord Cherwell. Sir Roy recounts some painful incidents in Oxford between the two World Wars; they bear credit to nobody and to no institution, and it is perhaps a pity that they could not have been left in the senior common room atmosphere in which they originated. There are, however, some interesting glimpses of Oxford twenty to thirty years ago, as seen by a humanist with an active sympathy for science. We in the laboratories often felt that there was a prejudice against science in the University, but we could not be sure that we were not being unduly sensitive. Sir Roy, as an onlooker, makes it quite clear that the prejudice did exist, and that Lord Cherwell fought it valiantly. Whatever may be said in criticism of his personal efforts in research after the First World War, he led the advancement of the Clarendon Laboratory; he was also one of the foremost in getting the place of science recognized in Oxford, and indeed in Britain generally.

Sir Roy reflects on some of the reasons for the comparatively small amount of research in physics personally undertaken by Lord Cherwell after 1919. There is one further reason that ought to be taken into account; many of us who found ourselves in positions of high activity during the War know that it was not easy to settle again into the quieter pursuit of research, particularly if it seemed that various aspects of national defence with which we ourselves had been formerly associated were not being properly developed. It is more than possible that this same uneasiness distracted Lord Cherwell; it certainly led him to spend much effort on air defence matters after 1933.

As regards the Second World War, Sir Roy Harrod mainly confines himself to his subject's activities in the fields of economics and logistics, and these show the surprising extent to which Lord Cherwell's interests went beyond physics. The reader may, however, be led to draw an incorrect conclusion from the fact that Cherwell had eight economists on his staff in 1940, and only one scientist. The numbers do not reflect the relative depths of his interests; many of the scientific factors were so deeply in his mind that one assistant was perhaps all that he required—and in any event there were scientists throughout the Government service on whom he could always call. It is probably this field of Cherwell's activities, the use of science in war, on which least has yet been published, and which will be of the most general interest. Sir Roy hints at some of the pre-war difficulties that arose in Sir Henry Tizard's Committee for the Scientific Survey of Air Defence, in the Air Ministry, but he appears to have heard only a fragment of the story; more is to be found in Vol. 1 of Sir Winston Churchill's war memoirs. The Tizard Committee was one of the most distinguished and effective bodies ever to serve Great Britain, and it is impossible not to sympathize with the Committee which, having discussed and rejected some of Cherwell's ideas at Air Ministry level, then found them proposed afresh but unaltered in the still higher forum of the Committee of Imperial Defence. At the same time, one can appreciate Cherwell's earlier chagrin on finding that the Air Ministry, by forming the Tizard Committee, had forestalled his proposal for a committee on science in air defence at the highest political level.

Many of the details, both of this story and of others later in the War, if they are told, will not make complaisant reading. But they will be of extreme interest, and they may be expected to confirm the impression warmly given by Sir Roy Harrod that, even with the contradictions of his character, there was much to like and admire in 'the Prof'. The wisdom of some of his acts may be questioned, but science in Britain is the stronger for his efforts.

R. V. JONES

ASPECTS OF SOLID STATE PHYSICS

Solid State Physics

Advances in Research and Applications. Edited by Frederick Seitz and David Turnbull. Vol. 4. Pp. xiv+540 (1957). 12 dollars. Vol. 5. Pp. xv+455 (1957). 11 dollars. Vol. 6. Pp. xiv+429 (1958). 12 dollars. (New York: Academic Press, Inc.; London: Academic Books, Ltd.)

THESE three volumes of a series initiated in 1955 contain seventeen articles, of length ranging from 9 to nearly 200 pages, on various aspects of solid state physics. It is scarcely possible, even if it were desirable, to attempt to give, in a single review, a critical assessment of all these articles. As the series expands, something like a balanced survey of a very wide field may be approached asymptotically by the aggregate of articles. Each particular volume, however, contains a rather mixed bag, and the only way of giving an objective indication of the contents is by listing the articles with brief annotations.

The longest article in Volume 4 is that on ferroelectrics and anti-ferroelectrics by W. Känzig, who surveys the field comprehensively, brings out the similarities and differences between ferromagnetics and ferroelectrics, and usefully prefaces the detailed accounts of particular materials by general summaries. The theory of mobility of electrons in solids is reviewed by F. J. Blatt. It is notable that, although the general principles underlying the interpretation of transport effects are well established, it is only rarely that good quantitative agreement between theoretical and experimental results has been obtained, and that, in this respect, the treatment of metals still lags well behind that of semi-conductors. The value of investigations of single crystal specimens of high purity and perfection is reflected in the account, by W. G. Pfann, of the techniques of zone melting and crystal growing. Another kind of technique is described by T. O. Woodruff in his article on the orthogonalized plane-wave method, exemplified by its application to silicon, for which the results obtained seem disappointingly inconclusive. A "Bibliography of Atomic Wave-functions" by R. S. Knox is essentially an extension to 1957 of a list of references compiled by Hartree some ten years earlier.

Volume 5 includes a full discussion, by M. H. Cohen and F. Reif, of quadrupole effects in nuclear magnetic resonance, with particular emphasis on the way in which the splitting and broadening of lines provides information about the internal electric fields in solids. Galvanomagnetic and thermomagnetic effects in metals are surveyed by J.-P. Jan, and discussed in terms of a two-band model. A unified treatment of the irreducible representations of the space groups, relevant to solutions of the Hamiltonian for perfect solids, is given by G. F. Koster, assuming a knowledge in the reader of the general theory of groups and their irreducible representations. C. C. Klick and J. H. Schulman deal with luminescence in solids, emphasizing the basic physical principles involved and discussing primarily inorganic phosphors. Shallow impurity states in silicon and germanium are treated by W. Kohn, who describes the empirical facts, and discusses the extent to which, in particular by advances in the theory of donor states, it has been possible to correlate a wide range of electrical, optical and magnetic properties.

There are seven articles in Vol. 6, as compared with five in the other two volumes, the subject-matter ranging from the primarily experimental to the purely theoretical. There is an extensive review by W. W. Piper and F. E. Williams on recent work on the complex phenomenon of electro-luminescence, with special reference to the basic mechanisms, and to the behaviour of zinc sulphide. The compression of solids by strong shock-waves is treated by M. H. Rice, R. G. McQueen and J. M. Walsh, who describe how modern high-explosives experimentation has extended empirical knowledge of pressure-volume relations far beyond the range over which precise static compressibility studies have been made. Experimental work during the past decade on secondary electron emission induced by electron bombardment is reviewed by A. J. Dekker. A much wider time range is covered by the article by M. P. Givens on experimental and theoretical work on the optical properties of metals, a subject which has fallen outside the main fields of recent research. D. L. Dexter presents a general account of the basic theory of the optical properties of imperfections in non-metals. An article by G. Borelius on changes of state of simple solid and liquid metals is essentially a summarizing survey of a recent series of papers by him dealing with a semi-macroscopic analysis of energy, entropy and volume into vibrational and structural parts. Finally, there is an account of macroscopic symmetry and properties of crystals by C. S. Smith in which a systematic development of the formal theory is supplemented by physical arguments, and applied in the discussion of a wide range of physical properties.

There is no doubt that most of the articles in these volumes will be of value to those engaged in, or preparing to undertake research on, the topics with which they are concerned. This would hold even of articles which are essentially compilations of condensed information about work presented in many different journals, or which are advanced expositions of some particular theoretical topic. A reader with a good general background knowledge of solid state physics, for whom this series is intended, may, however, properly wish to be conducted into some more particularized field, rather than pushed into it. Such a reader will emerge from some of these articles with no clear impression at all. The writers, as guides, are often too conscientious, too modest, or just plain indifferent: too conscientious in trying to make reference to every piece of work they have been able to find; too modest in not allowing any trace of personal judgment, even by selection, to become apparent; or plain indifferent in not caring whether a condensed piece of theoretical exposition is likely to be intelligible to an average reader or even, sometimes, whether it is intelligible to themselves.

In these volumes there is a theoretical article which begins at a level so far beyond that of most physicists as to be virtually useless by itself in this form. Another theoretical article is a first-rate piece of exposition, at an appropriate level, though even this jumps the traces occasionally, and would be improved by the addition of a few explanatory sentences or paragraphs. On the more experimental side there is an article which contains more than seventeen pages of tables, mostly of experimental data of very specialized interest, which are completely out of place in a series of this kind. Other primarily experimental articles suffer from a congestion of factual material. In some, however, much thought has clearly been given to presenting a clear and balanced picture of a particular field, at the expense of omissions which are likely to be deplored only by a few of the less able writers of Ph.D. theses.

The adverse comments which have been made must not be taken to imply that the average standard of the articles in these volumes is unusually low; indeed, compared with the general run of review articles, it is unusually high, in keeping with the already established reputation of the series. Even here, however, the prevalent diseases of review articles and their writers are becoming apparent: the spotted reference fever of the one, and the introversion of the other. These can be controlled, and when they are, and other more positive conditions are satisfied, review articles may result which, like a few of those here, are in their own right substantial contributions to science.

I am indebted to my colleagues Dr. P. Rhodes and Dr. E. F. W. Seymour for also reading a number of the articles in these three volumes, and giving me the benefit of their comments. E. C. STONER

MUSIC AND ELECTRONIC COMPUTORS

Experimental Music

Composition with an Electronic Computer. By Prof. L. A. Hiller, Jr., and Leonard M. Isaacson. Pp. vii+197. (London: McGraw-Hill Publishing Company, 1959.) 46s. 6d.

So much is heard nowadays of the capabilities of the computer robot in imitating every human activity that it is not surprising to read of experiments in which the computer is made to compose music. Perhaps to say that the machine 'composes' is putting the experiments described in this book at too high a level, as probably the authors would be the first to admit. What the computer has been asked to do is, in fact, to produce a *canto fermo*, a series of notes following certain rules which every student of harmony has to practise at an early stage of the music course. Since these rules are largely negative, it is, of course, quite easy to feed into it a programme in which it may choose the next note at random, provided it does not, for example, form a tritone, jump more than an octave, and so on. The result is something which will pass a music examiner, or would have done in the past century, but is scarcely a composition. It is rather like asking a laboratory technician who can blow glass, solder, join wood and nothing more to carry out an original piece of research.

This writing of a *canto fermo* is not the sole musical experience of this particular electronic computer. There are others, and the authors have gone so far as to orchestrate them for string quartet. Read as scores (given in the text) they are not very impressive. One cannot expect to create a mechanical Bach or Mozart, but it evidently takes more than a few programmes to endow our robot with the divine afflatus which could produce even a simple folk tune. Nevertheless, these experiments are amusing and the account of them is well written, so that one does not need to be a *habitué* of the computer room to understand what the authors were planning.

E. G. RICHARDSON

SEMICONDUCTORS

Optical Properties of Semi-Conductors

By Dr. T. S. Moss. (Semi-Conductor Monographs.) Pp. x+279. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1959.) 50s.

Fluctuation Phenomena in Semi-Conductors

By Prof. A. Van der Ziel. (Semi-Conductor Monographs.) Pp. viii+168. (London: Butterworths Scientific Publications, 1959.) 35s.

Progress in Semiconductors

Vol. 3. Edited by Dr. Alan F. Gibson, Prof. R. E. Burgess and Prof. P. Aigrain. Pp. viii+210. (London: Heywood and Co., Ltd., 1958.) 55s. net.

An Introduction to the Theory and Practice of Semiconductors

By Dr. A. A. Shepherd. Pp. 206. (London: Constable and Co., Ltd., 1958.) 18s. 6d. net.

Half of Dr. Moss's book gives a general discussion of the theory of optical effects in solids. The other half presents summaries of the optical properties of a range of semiconducting elements and compounds. Although these summaries are brief they are meaty and well supplied with references and would seem a useful supplement to a general text-book on solid state physics: a reminder of the complexity of the subject and of the tenuous physical basis of some of the more elaborate mathematics.

Prof A Van der Ziel has written a clear and thorough book on the present status of the theoretical and experimental work on fluctuation phenomena, or electrical 'noise' in semiconductors. Both the above books are in the series of "Semiconductor Monographs".

Volume 3 of "Progress in Semi-Conductors" includes articles entitled: the magnetoresistivity of germanium and silicon, the chemical purification of germanium and silicon, electronic conductivity of silver halide crystals, silicon junction diodes, lifetime of excess carriers in semiconductors, scattering and drift mobility of carriers in germanium, and electronic processes in cadmium sulphide. An index is provided.

Some years ago the study of silicon and germanium became a popular *folie* and vast sums have been devoted to it. But even if these elements seem predominant when looking out from the centre of a vast industrial structure built upon their semiconducting properties, the student of semiconductors should surely have the subject presented with more judiciously chosen proportions. Despite its title, "An Introduction to the Theory and Practice of Semiconductors", Dr A A Shepherd's book is mainly restricted to some technological aspects of the adamantine structures.

R A Hyman

INTERNATIONAL CONFERENCE OF RADIO ASTRONOMERS

Paris Symposium on Radio Astronomy

Held from 30 July to 6 August, 1958. Edited by Ronald N Bracewell. (International Astronomical Union. International Scientific Radio Union.) Pp xii+612. (Stanford, Calif: Stanford University Press, 1959.) 15 dollars.

MORE than 160 of the scientists who work in the rapidly growing branches of radio astronomy, or in related subjects, attended a symposium in Paris in July 1958. This was a useful preliminary meeting to the tenth Assembly of the International Astronomical Union in Moscow a month later. The volume under review contains the proceedings of the Paris symposium, and the editor and publishers are to be congratulated that they have fulfilled the time-table outlined for the symposium, and have produced this large volume of proceedings within twelve months of the meetings. The volume is divided into six parts, each of which opens with an introductory lecture given by one of the leading scientists in the field. There follow 10–30 papers, and significant contributions to the discussion which followed each paper, or group of papers. Particularly valuable are the concluding lectures at the end of each part of the book. In these lectures distinguished astronomers attempted to relate the often diverse individual papers, and to emphasize those parts of the subject where theoretical discussion or further observations seemed to be most needed.

The first half of the book deals with radio studies of the solar system. There is a short section on radio-echo observations of the Moon, and on the thermal radiation at millimetre wave-lengths from the Moon, Venus, Jupiter and Saturn. This is followed by a much longer section on radio observations of the Sun, and the classification and interrelation of the variable solar emissions.

The second half of the book contains two sections dealing with the emissions from galactic and extra-galactic sources, and the study of galactic structure by means of the 21-cm line of neutral hydrogen. Some may regret that the papers on hydrogen line work are divided rather artificially between these parts 3 and 4 of the book, but all must welcome the successful 'marriage' of observations from Leyden and Sydney, to give a map of our galaxy which is almost complete, and very detailed. The accuracy of this work has led to a re-definition of the galactic pole which is more accurate by an order of magnitude than the earlier definition based on optical observations. The detection of radial motions of the gas in the central parts of our galaxy will act as a further stimulus to the theoretical work on the stability of spiral structures.

Section 5, on discrete sources and the universe, contains probably the most vigorous of the discussions at the symposium. This centred about the problems, first, of the great preponderance of the radio sources with which optical objects have not yet been identified, and, secondly, the attempts to extract cosmological information about the origin and evolution of the universe from the statistics of the unidentified sources. More measurements of angular size and source intensity are urgently needed, so that the sources may be classified by their surface brightness, and the statistics of a reasonably homogeneous group of sources can be studied. There are grounds for hope that radio astronomers can provide observations of cosmological significance, but these results have probably still to appear.

The last part of the book is on the theory of solar and cosmic emission mechanisms. There is now wide agreement that most non-thermal cosmic radiation is generated by a synchotron process, in which electrons moving with relativistic speeds suffer accelerations and spiral motion in magnetic fields. One outstanding problem is the connexion between the relativistic electrons and the cosmic-ray flux and its energy distribution. Some workers argue that cosmic rays originate in supernova explosions. Others suggest that the cosmic-ray flux is a manifestation of a universal hot gas from which the galaxies condensed. On this latter theory, radio emission occurs whenever the magnetic field is increased by compression of the gas, which may be due to local cooling, to stellar explosions, or to galactic interactions.

The radio studies of the solar system and of the galactic and extra-galactic radio sources had seemed rather distinct, though one speaker emphasized that they were linked by an incomplete understanding of the mechanisms of emission. Simple extrapolation suggests that the proceedings of a further conference would fill a volume of unmanageable size. Perhaps any future symposium could be divided even more clearly, so that the proceedings could appear in separate, smaller, and less expensive volumes.

This volume is liberally supplied with diagrams, tables and half-tone photographs, and there are very few printers' errors. It will be an extremely useful and up-to-date reference book and bibliography for all working in radio astronomy, though few will read every paper It is surely indispensable to all libraries with an astronomical section, and those who can afford private copies will find it very easy to lend to their astronomical friends H P PALMER

MODERN INORGANIC CHEMISTRY

Advances in Inorganic Chemistry and Radiochemistry

Vol 1 Edited by H J Emeléus and A G Sharpe Pp xi+450 (New York: Academic Press, Inc , London Academic Press, Inc (London), Ltd , 1959) 12 dollars

WITHIN the past twenty years inorganic chemistry has recovered from a moribund state to be, with radiochemistry, a fast-growing and extremely active branch of chemical science Modern inorganic chemistry ranges from physical chemistry and pure radiation chemistry through analytical chemistry to the study of organo-metallic compounds It is satisfying that this present volume reflects this wide range of interest

In the first chapter, H Taube writes on "Mechanisms of Redox Reactions of Simple Chemistry" This chapter is difficult reading for the non-specialist, who is not helped by a lack of clearness of the definitions of the various terms used However, the actual discussion is extremely clear and contains many details of reactions which the inorganic and analytical chemist tend to think of as simple but which are, as yet, very imperfectly understood The other chapter of interest to the analytical chemist is on "Activation Analysis", by D H F Atkins and A A Smales This review should be of use to all interested in the determination of microgram and sub-microgram quantities of the elements, but would have been improved by a comprehensive table of the various isotopes and methods used in analysis Again, on the physical side T C Waddington has given an important review of "Lattice Energies and Their Significance in Inorganic Chemistry" The author includes a brief survey of methods of calculation followed by tables of values, many of them newly calculated G Harbottle and N Sutin have written on "The Szilard–Chalmers Reaction in Solids" As an inorganic chemist, I found this chapter disappointing, as the treatment is mainly from a physical point of view and the chemical effects of the Szilard–Chalmers reaction are not dealt with in great detail

On the structural side, W N Lipscomb writes on "Recent Studies of the Boron Hydrides" The order that X-ray crystallography and topological treatment of these and related compounds has brought to this previously intractable subject is one of the most æsthetically satisfying developments in modern inorganic chemistry W Rudorff discusses "Graphite Intercalation Compounds" In view of the extensive use of graphite, often under the most rigorous conditions, in industry the importance of the study of these compounds is clear

Finally, there are three articles on purely inorganic subjects "Compounds of Aromatic Ring Systems and Metals" by E O Fischer and H P Fritz is potentially a most interesting chapter on a field which has only existed for the past eight years Although factually almost complete, the chapter is disappointing because lack of tabular presentation of the material makes comparison and cross-reference difficult N L Paddock and H T Searle write on "The Phosphonitrilic Halides and Their Derivatives" There is currently a very rapid development in the field of inorganic polymer chemistry, and this chapter does full justice to one homologous series Finally, R J Gillespie and E A Robinson deal with "The Sulphuric Acid Solvent System" The use and study of non-aqueous solvents is now widespread in inorganic chemistry and this chapter discusses the inorganic applications of what is probably the best understood system

The volume is extremely well produced and almost free from typographical errors, the omission of all the arrows from one Born–Haber cycle being the most noticeable mistake My major regret is that the high price will probably mean that it will be purchased only by libraries, and for the complete success of reviews they should be owned by the individual There is certainly a need for a volume of reviews on inorganic chemistry, and if the editors can obtain articles of the present standard and interest for succeeding volumes the success of the series is assured D W A SHARP

CLASSICAL CHEMICAL ANALYSIS

Comprehensive Analytical Chemistry

Edited by Prof Cecil L Wilson and David W Wilson Vol 1*a* Classical Analysis. Pp xi+577 (Amsterdam Elsevier Publishing Company , London D Van Nostrand Company, Ltd , 1959) 105*s*

THIS book forms the first part (*a*) of Vol 1 of Elsevier's "Comprehensive Analytical Chemistry" which is to consist of five distinct volumes, some containing several parts Vol 1*a* (to be followed by 1*b* and 1*c*) deals with classical methods of analysis and contains six distinct chapters Each chapter contains contributions from authorities in particular fields of analytical chemistry and there are, including editorial contributions, a total of nineteen individual authors in the present book

The subject-matter is essentially of an introductory and general nature which is of importance in all branches of analytical chemistry , but included also are processes of sufficiently long standing that they can come under the general heading of "Classical Analysis Chapter 1 is the editorial introduction to the entire work This is followed by a chapter headed "Analytical Processes", which contains sections on materials, sampling, statistics, weighing, measurement of volume, solvent extraction, organic reagents in inorganic analysis, and occupies some 220 pages Chapter 3 (87 pages) deals exclusively with gas analysis, Chapter 4 (68 pages) with inorganic qualitative analysis, and Chapter 5 (32 pages) with organic qualitative analysis Chapter 6 (115 pages) treats the subject of inorganic gravimetric analysis

In the main, this first part lives up to the standard expected from the general title , but in certain sections individual bias has prevented a truly comprehensive presentation of material and this is most marked in the chapters on inorganic and organic qualitative analysis Here one might reasonably have expected to find a critical account of the various systems and schemes of analysis rather than a detailed discussion of one preferred system Fortunately, this does not happen to any such extent in other chapters , in fact, the chapter on gas analysis goes almost to the other extreme and presents the important aspects of the subject in a methodical and critical way

Altogether, ' Comprehensive Analytical Chemistry" has got away to a good start There are bound to be a number of blemishes in such an ambitious work, but whether these will detract seriously from the value of the completed volumes is scarcely answerable at present Undoubtedly this will become a standard reference work in analytical chemistry, but like all such extensive publishing projects, there is a considerable danger that, by the time the final volume comes from the press, the earlier volumes will be outdated The rapid development of new methods and techniques in many branches of analytical chemistry tends to lessen the value of this encyclopædic type of text, except as a means of collecting together the available information at the time of writing Too often publishing delays result in the presentation of much out-dated material, which the authors and editors are powerless to prevent

This book has the dubious advantage over four other (to the reviewer's knowledge) similar projects in being first in the field As such it is bound to come in for a good deal of comment not all of which will be friendly Nevertheless, on the basis of this first volume, an appreciably high standard has been set for the complete work, and the appearance of the subsequent parts and volumes is awaited with considerable interest Elsevier are to be congratulated on the fine printing and particularly the binding of this book which, as the series is completed, will add grace to the shelves of many libraries

WILLIAM I STEPHEN

ION EXCHANGE

Ion Exchange Resins

By Robert Kunin. Second edition Pp. xiii+466 (New York · John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1958) 88s. net

Ion Exchange

A Laboratory Manual By Dr J E. Salmon and D K Hale Pp vii+136. (London Butterworths Scientific Publications , New York Academic Press, Inc , 1959) 25s , 5 dollars.

WHEN the first edition of "Ion Exchange Resins" by Kunin and Myers appeared in 1950 it was only the second book on the subject in the English language Since then, five more such books have appeared However, only two of these have attempted general treatments of the subject and these two are brief monographs There is still, therefore, plenty of scope within the covers of a single volume for a full length up-to-date account in English of ion exchange in all its aspects, fundamental and applied This is what Dr Kunin has attempted He has certainly succeeded in considerable measure The present work is both bigger and better than the first edition Dr Kunin's greatest successes are in the chapters on ion exchange application, He has done less well on the fundamental side

Some of the faults of the first edition are still to be found here a large number of diagrams, not always very clearly labelled or explained in the text , the occasional full account of older (sometimes obsolete) theories (particularly of ion exchange equilibria) with an inadequate amount of some of the recent work In dealing with cation exchange kinetics on carboxylic exchangers Dr Kunin repeats almost verbatim the account given in the first edition The only reference he quotes in connexion with this topic is some work of Kunin and Barry in 1949 A few papers on this topic have been published since then but no mention is made of them In particular, he ignores the important theory of Bauman, which many would consider to be at least as plausible as the theory of Kunin and Barry However, the chapter on the synthesis of ion-exchange resins is a very great improvement on that in the earlier edition and there are excellent chapters on permselective membranes and catalysis with ion-exchange resins In general, anyone reading the more fundamental parts of this book would be advised to refer also to other books (Kitchener or Griessbach) to check, supplement or correct the impressions gained However, this book may be recommended as a useful reference work, particularly with regard to ion-exchange applications

Dr Salmon and Mr Hale have broken completely new ground in their book This splendid little book is an attempt (the first, so far as I know) to teach ion exchange to students by means of a carefully planned series of experiments The first five chapters form a theoretical introduction to the remainder of the book, which contains the experiments The discussions of the experiments form a particular feature of the book and they are both clear and stimulating The authors' statement (p 116) that "The regeneration of a mixed-bed column is not readily achieved with small laboratory columns" may not command universal assent, and the consequent omission of any account of such regeneration procedures is open to criticism Indeed, many workers would probably prefer a straightforward mixed-bed column for de-ionization to the three-stage procedure described by the authors However, these are comparatively minor points which later editions may remedy This book deserves every success, as it should be useful not only to students but also to all laboratory workers who have anything to do with the practical side of ion exchange

D REICHENBERG

GEOCHEMICAL RESEARCH IN THE UNITED STATES

Researches in Geochemistry

Edited by Philip H Abelson Pp x+511 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1959) 88s net

THIS book, edited by the Director of the Geophysical Laboratory, Washington, is the outcome of a seminar series in geochemistry organized by the Geophysical Laboratory and held there, and at the Johns Hopkins University, during the academic year 1957–58

It gives a valuable conspectus of current geochemical research in the United States, and the wide range of topics covered is best indicated by listing the titles of the contributions (authors' names in brackets) sedimentation on the ocean floor (G O S Arrhenius), pp 1–24 , rates of geochemical reactions at low temperatures and pressures (R M Garrels), pp 25–37 , geochemical indicators of marine and fresh-water sediments (M L Keith and E T Degens), pp 38–61 , geochemical prospecting (H E Hawkes), pp 62–78 , geochemistry of organic substances (P H Abelson), pp 79–103 , some chemical aspects of petroleum genesis (W E Hanson), pp 104–117 , mineral assemblages of the Green River Formation (C Milton and H P Eugster), pp 118–150 , tritium in hydrology and meteorology (W F Libby), pp 151–168 , measurement and use of natural radiocarbon (H de Vries), pp 169–189 , geochronology (G R Tilton and G L Davies), pp 190–216 , the variation of the ^{18}O/^{16}O ratio in Nature and some geological implications (S Epstein), pp 217–240 , isotopic fractionation of sulphur in geochemical processes (W U Ault), pp 241–259 , the use of equilibrium calculations in finding the composition of a magmatic gas phase (K B Krauskopf), pp 260–278 , the chemical environment of ore deposition and the problem of low-temperature ore transport (P B Barton, Jr), pp 279–300 . sulphide systems as geological thermometers (G Kullerud), pp 301–335 , some aspects of the geochemistry of carbonates (J R Goldsmith), pp 336–358 , diffraction effects of short-range ordering in layered sequences (F Chayes), pp 359–376 , hydrothermal investigations of amphiboles (F R Boyd), pp 377–396 , reduction and oxidation in metamorphism (H P Eugster), pp 397–426 , local equilibrium in metasomatic processes (J B Thompson, Jr), pp 427–457 ; activation analysis applied to geochemical problems (G W Reed), pp 458–475 , chondrites and the chemical composition of the Earth (G J F MacDonald), pp 476–494 , equations of state and polymorphism at high pressures (S P Clark, Jr), pp 495–511 Each article has a good selected bibliography, and the book is well produced and printed It is to be regretted that there is no index

It would be invidious to single out particular articles where all are of high standard, and it is sufficient to say that this book should be of great interest not only to geochemists wishing to have authoritative accounts of work in fields other than their own but also to geologists in general

S R Nockolds

HETEROCYCLIC CHEMISTRY

Chemistry of Carbon Compounds

A Modern Comprehensive Treatise Edited by Dr E H Rodd Vol 4, Part B · Heterocyclic Compounds Pp xviii+809–1464 (Amsterdam Elsevier Publishing Company , London D Van Nostrand Company, Ltd , 1959) 100*s*

s-Triazines and Derivatives

By Edwin M Smolin and Lorence Rapoport (The Chemistry of Heterocyclic Compounds a Series of Monographs, Vol 13) Pp xxiv+644 (New York Interscience Publishers, Inc , London Interscience Publishers, Ltd., 1959) 226*s* net

BOTH the above works are massive volumes of well over six hundred pages which are packed with detailed information to give a true review, that is, one which critically assesses the contents and their presentation, of either volume in a short space is therefore almost impossible

Vol 4*B* of Rodd's "Chemistry of Carbon Compounds" is an impressive work, in which a uniformly high standard is maintained by the seven contributors Dr Neil Campbell has written a considerable chapter on six-membered ring compounds having oxygen and/or sulphur in the ring, thus including in particular pyran, chromen, benzochromens, the corresponding thia-analogues and the many derivatives of each class He has also contributed a shorter chapter on compounds having two fused five- or six-membered rings with a nitrogen or oxygen atom in each ring These chapters are divided by an account by Sir Robert Robinson of brazilin and hæmatoxylin this article by so great an authority makes one deeply regret that Sir Robert has been too busy to make further and fuller contributions to the volume An excellent chapter on the cyanine and related dyes, giving a necessarily condensed but very clear account of this vast range of fascinating compounds, has been written by Dr G de W Anderson Dr T S Stevens has contributed a chapter on the indigo group, and another very considerable chapter on the pyrrole pigments, which contains among many other interesting subjects an excellent account of the chemistry of chlorophyll and of vitamin B_{12} Dr Stevens has also collaborated with Dr Ishbel G M Campbell in a final chapter on "Compounds containing Unusual Hetero Atoms", that is, silicon, phosphorus, arsenic, antimony, bismuth, halogen and certain metallic atoms This deals with a section of heterocyclic chemistry which is usually omitted in textbooks, but which is of absorbing interest in its own right, apart from being a refreshing change from nitrogen compounds It can be strongly recommended as a really modern review of this field Incidentally, the chemistry of silicon and phosphorus is expanding so rapidly that these elements will soon cease to be 'unusual hetero atoms'

The editor and the contributors are to be warmly congratulated on this excellent volume, which will so greatly enhance the value of the complete work

"*s*-Triazines and Derivatives" is the thirteenth volume to appear in the Interscience "Chemistry of Heterocyclic Compounds" Series, which has now become by far the major series to give a modern account of this vast division of organic chemistry The authors state that the subject-matter of this book was originally intended to be part of a single volume dealing with triazines and tetrazines, but that the immense amount of material necessitated two volumes, the first, on 1,2,3- and 1,2,4-triazines and tetrazines by Drs Erickson, Wiley and Wystrach, having been recently published as the tenth volume in the series, and this second volume is now devoted to *s*-triazines, including the purely inorganic system *s*-triazaboranes

This volume deserves to receive a wide welcome, from both academic and technical chemists Many academic chemists have only a general knowledge of many of the classes of compounds discussed. and should warmly welcome the clear and detailed account here presented many of these compounds, moreover, are of considerable and steadily increasing technical application, and the volume should therefore also be of great interest to technical chemists As an example, the chemistry of cyanuric acid, its halides, esters and other derivatives is discussed in a chapter of 120 pages the treatment ranges from a very full discussion of the physical properties of cyanuric acid to the application of its derivatives in many branches of chemistry such as dyestuffs, pesticides, resins, explosives and also in medicine Melamine and *iso*cyanuric acid are two other compounds of considerable theoretical and technical interest, and a chapter is devoted to each compound and its derivatives Condensed ring *s*-triazine systems, and hexahydro-*s*-triazines also receive a detailed and logical discussion in separate chapters All the above compounds contain the same six-membered ring system of alternating carbon and nitrogen atoms, usually of considerable stability The reader therefore may come with some surprise to hexamethylenetetramine, the whole chemistry of which is so different from that of the preceding compounds this compound does, of course, contain three such rings fused uniquely together, and the full account of its reactions is to be greatly welcomed Both inorganic and organic chemists will also welcome the final chapter on *s*-triazaboranes

The author and the publishers may be justly proud of this volume, which will give added strength to the whole Interscience series The reviewer feels that the chemical public are also indebted to the American Cyanamid Co , which has ensured facilities for the writing of this considerable volume by two members of its staff, and also for the contribution to Vol 10 by another member, Dr Wystrach

F G Mann

ENZYMES

Outlines of Enzyme Chemistry

By J B Neilands and Paul K Stumpf With a Chapter on the Synthesis of Enzymes by Roger Y Stanier Second edition, revised and enlarged Pp xii+411 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1958) 68*s* net

The Enzymes

Edited by Paul D Boyer, Henry Lardy and Karl Myrback Vol 1 Kinetics, Thermodynamics, Mechanism, Basic Properties Second edition, completely revised Pp xiii+785 (New York Academic Press, Inc , London Academic Books, Ltd , 1959) 24 dollars

THE two books reviewed here deal with the same subject but at a very different level They are aimed at different readers, but each in its class should prove extremely valuable

This second edition of "Outlines of Enzyme Chemistry", by Drs Neilands and Stumpf, has undergone considerable changes and has expanded by about one-third compared with the first edition It is intended for the beginner and gives a concise and fairly elementary coverage of the whole field of enzymology Also included is a certain amount of background material which will be very helpful to the student , for example, there is an excellent section on physical chemistry which leads smoothly into the discussion of enzyme kinetics Some chapters carry the material to a very advanced level, and the book will undoubtedly be useful to many research biochemists as a reference book A new feature is an alphabetical list of more than five hundred enzymes, with some properties and key references

A large number of references is given throughout the book, but their selection appears in places to have been rather random The density of documentation is rather uneven , for example, there are only sixteen references after a chapter on oxidation-reduction, but 136 to a chapter on the classification of coenzymes

Vol 1 of "The Enzymes", under the editorship of Boyer, Lardy and Myrback, is the first of a series of four volumes to replace Sumner and Myrback's "The Enzymes Chemistry and Mechanism of Action", which since its publication in 1950 has become a classic work of reference It is not in any real sense a second edition, but a completely new work by new authors, arranged in a different way As the editors state in the preface, much of the material will be "supplemental to that of the previous edition and thus the previous edition will continue to serve as a useful reference work in certain areas" The new series will not deal with metabolic relationships, nor will it contain details of methods of preparation, etc , which can be found in the companion treatise, "Methods in Enzymology" The aim is to give a full account of enzymes and enzyme action "on a molecular level"

Vol 1 is devoted to kinetics, thermodynamics, mechanism and basic properties It stands on its own, in fact, as a text-book on the fundamental principles of enzymology There are four excellent chapters on enzyme kinetics, including a historical survey by H L Segal and the development of the complete steady-state rate equation by R A Alberty. The mechanism of enzyme action is discussed *inter alia* by R Lumry, D E Koshland, P D Boyer and H Fraenkel-Conrat There is a useful review of structural and stereospecificity by H Gutfreund Probably the most difficult chapters are by P George and J S Griffith on "Electron Transfer and Enzyme Catalysis", and by R J P Williams on "Co-ordination, Chelation and Catalysis" , but many enzymologists concerned with oxidation systems will be extremely grateful for these carefully written accounts of relevant fundamental chemistry Although much of the book is concerned with the fundamental chemistry of enzymes and enzyme action, the final two chapters, on enzyme induction by M R Pollock, and on the control of enzyme activity by A B Pardee, introduce a more biological note

There is no doubt in the reviewer's mind that, if the standard of this first volume is maintained, "Boyer, Lardy and Myrback" will be a worthy successor to the ubiquitous "Sumner and Myrback"

Edwin C Webb

HUTCHINSON'S 'FAMILIES'

The Families of Flowering Plants

By Dr J Hutchinson Second edition Vol 1 Dicotyledons Pp xi+510 Vol 2 Monocotyledons Pp viii+511–792 (Oxford Clarendon Press , London Oxford University Press, 1959) 147*s* net the two volumes

THIS well-known work by Dr J Hutchinson was first published in 1926 (Vol 1) and 1934 (Vol 2), and has long been out of print ; a second edition, in which the treatment of the dicotyledons has been expanded and greatly altered, has now been produced by the Oxford University Press This new edition will be welcomed by those interested in changing views about the evolutionary relationships of flowering plants and will be useful to students of taxonomy (if they can afford to buy it)

To begin with, it may be said that Vol 2 is unaltered except for the addition of one family and of genera which have been described since 1934, so that this review will be concerned mainly with the first volume

The two most striking innovations in this are the extensive changes in the order of the families and the addition of no fewer than 76 families, not recognized in the first edition. It seems unfortunate, in view of this and of its special interest, that Degeneria even if not accorded family rank should not be given fuller treatment.

Dr Hutchinson indicated in 1926, and has since emphasized, his belief in the fundamental importance of the difference between the woody and the herbaceous habit in dicotyledons. This view reaches its full expression here, and when combined, as it is, with the rejection of the customary criteria of polypetally and sympetally, leads to a complete rearrangement of families. Opinions will differ about the validity of this basis, but two things are certain: there is at present no means of proving or disproving the truth of Dr Hutchinson's views, and there is equally no denying that for the general practitioner of angiosperm taxonomy the adoption of the new system would be highly inconvenient.

This, of course, raises once again the question of the purpose of classification, and it appears that here there has been an attempt to achieve two rather incompatible ends.

The first and most important is the exposition of a new and revolutionary system of classification which, Dr Hutchinson believes, represents phylogenetic relationships and distinguishes them clearly from similarities due to parallel development from different stocks. Here there is, of course, endless room for discussion and for disagreement as well as agreement, but certain difficulties, one might almost say inconsistencies, soon come to light. Why, for example, are the Malvaceae regarded as belonging to Lignosae, except to keep them near the Tiliales? More than half the genera are wholly or partly herbaceous and the wood of many of the others is not particularly hard. The Globulariaceae, placed in Herbaceae, seem much woodier.

The statement of general principles adopted for classification is the same as in the first edition, though some minor revisions might have been expected, notably in the assertion that compound leaves are derived from simple ones. The principles are not always rigorously applied or surely the Compositae would have displaced Labiatae as "the climax development of the fundamentally herbaceous line of evolution".

The second purpose of this work, and one which will be found generally useful, is the concise description of the families recognized and the provision of keys by which an unknown plant can be referred to its family. From the purely practical point of view it seems to me that it would have been more useful to have had this part of the book issued separately and arranged according to one of the better known, though phylogenetically unsatisfying, systems. These systems are fossilized in herbaria, and will remain so, since it is impracticable to rearrange even a moderate-sized herbarium every time views on classification of families change. Every working taxonomist will therefore continue to need an acquaintance with the systems of Bentham and Hooker and of Engler, so time would be saved and convenience increased if Floras and other reference books followed one of them.

If a separation of this kind had been made it might have been possible to devote more space under each family to a discussion of the reasons for the classification.

The book is well produced, as is to be expected from the Oxford University Press, though a few misprints, such as "Buddeeiaceae" on p. 101, have got by, and the drawing of what appears to be *Chenopodium capitatum* in Fig. 283 is still unlabelled. More serious is the absence of a number on p. 19, though this page is referred to by number in the text; the omission is doubtless in accordance with the best typographical practice but is annoying when one is trying to look it up. Even worse is the placing of the index to Vol. 1 on pp. 101–103 'for ready reference'. Reference would have been much easier if it had been put at the end of the volume in the usual way, though there is a suggestion on p. 101 that this was intended; if so it was overlooked.

In spite of these drawbacks the book is well worth a place in any botanical library for its iconoclastic treatment of conventional ideas, which should provoke thought and argument, and for the practical value of its keys and descriptions. T. G. Tutin

COCONUTS

The Coconut Palm

A Monograph. By Dr K. P. V. Menon and Dr K. M. Pandalai. Pp. xvi+384. (Ernakulam: Indian Central Coconut Committee, 1957.) Rs. 38; 85*s*.; 11.95 dollars.

SOUND monographs on the major crops are always welcome, not only to those with a specialized or professional interest but also to the general reader. A new work on the coconut palm by Dr K. P. V. Menon, director of the Central Coconut Research Station, Kayangulam, and Dr K. M. Pandalai, joint director of the Central Research Station, Kasaragod, comes into this category. The volume is published under the auspices of the Indian Central Coconut Committee, Ernakulam, South India.

The coconut palm, sometimes styled the 'Tree of Heaven', is still of unknown origin though the best contemporary opinions are in favour of a location in south-east Asia. It now occurs in littoral regions throughout the Tropics. In those regions, for example, India and Ceylon, where it is grown as a major crop, it not only constitutes the general economic basis but also provides many essential and accessory domestic materials. The nut, it need scarcely be said, is the principal article of commerce. According to the authors, the present position in India is that although there is indeed a vast production of nuts, this is still inadequate, and considerable imports of coconut products from Ceylon, Malaya, etc., are essential. After a bad period in the 1930's and during the Second World War, the industry was in a parlous position. To improve matters, the General Coconut Committee was set up in 1945 to take all necessary measures for the improvement and development of the industry. The present volume is one of the results of this new and important effort.

Several books devoted to the coconut have already been published. In the present work use has been made of them and of other relevant information, the overall effect being that the reader is presented with an unusually full and thoroughly documented account of this crop in its many aspects. The opening chapters are devoted to the origin and importance of the coconut, its general morphology, floral biology, varieties, breeding and the effect of environmental conditions. The following chapters deal with the production of quality planting materials, field culture, soil conditions, especially in their nutritive aspects, plantation management and yield. Other chapters are devoted to diseases and pests, of which there is no scarcity. There are also interesting and useful chapters on the tapping of the plant for its juice, curiosities or abnormalities in the development of the plant, and the utilization of its many and varied products. In the final chapter, the many outstanding problems in contemporary coconut research are discussed. In attempts to improve the industry, it need scarcely be said that the introduction of varieties and strains, and a considerable breeding programme, occupy an important place.

The book is very fully documented and well illustrated, some of the coloured plates and photographs being of very good quality indeed. It is hard to avoid the impression that research on the coconut palm is by no means as advanced as it ought to be; but what is known is faithfully presented in the volume under review.

C. W. WARDLAW

HORMONES IN CRUSTACEANS

Endocrine Control in Crustaceans

By David B. Carlisle and Sir Francis Knowles, Bart. (Cambridge Monographs on Experimental Biology, No. 10.) Pp. vii+120+5 plates. (Cambridge: At the University Press, 1959.) 21s. net.

COMPACT books, along with compact cars, provide a welcome relief in some of the more crowded parts of this world. Limited size, but not this alone, contributes to the popularity of the series of monographs of which "Endocrine Control in Crustaceans" is Number 10. Dealing mainly with developments of the past ten years, this book discusses the phenomenon of neurosecretion and contributions to this relatively new field resulting from studies on the Crustacea. Neurones, modified for secretion, have been found in most animals that have been examined, but their organization into systems and the roles of the neurohormones that these systems produce are best understood in the vertebrates, insects and Crustacea. The last-named have three principal types of neurosecretory systems: the so-called sinus gland system, the post-commissural organ system and the pericardial organ system. In each of these, the neurones end on blood spaces and release their products into the circulation, where they are distributed throughout the body to control a wide variety of physiological processes. In this book one finds a discussion of the anatomy of these systems, including fine structure, and the chemical nature and physiological actions of the hormones that they produce.

Since the sinus glands have been shown to consist of groups of nerve endings, modified for storage and release, only the rather recently described Y organs remain as 'true' endocrine glands in the Crustacea. Their role in the control of moulting and their obvious relation to the prothoracic glands of insects are discussed.

The authors point out some of the confusion that surrounds the identification and naming of components of the X organ-sinus gland system. This arises, in part, from the incomplete evidence that the 'sensory-pore X organ' is an important endocrine structure and the apparent desire on the part of some workers to link one important group of neurosecretory cell bodies of the eyestalk, the medulla terminalis ganglionic X organ, with the original X organ complex of Hanström. This matter and others pertaining to crustacean endocrines will be clarified in the next decade by workers who will find this compact book a most helpful résumé of our current understanding of this field.

J. H. WELSH

RENAISSANCE ANATOMY

A Short Introduction to Anatomy (Isagogae Breves)

By Jacopo Berengario da Carpi. Translated with an Introduction and Historical Notes by L. R. Lind, and with Anatomical Notes by Paul G. Roofe. Pp. xi+227. (Chicago: University of Chicago Press; London: Cambridge University Press, 1959.) 37s. 6d. net.

JACOPO BARIGAZZI (c. 1460–1530), or, as he is traditionally known, Berengario da Carpi, was a near-contemporary of Leonardo da Vinci, whose magnificent amateur exploration of the human body stands in fascinating contrast to the work of this competent but uninspired professional. Berengario was a successful physician among the tough characters of Renaissance Italy. Whatever the merits of his medical practice (he cured Lorenzo de' Medici of a skull wound but Cellini reports that he crippled scores of wealthy syphilitics in Rome), he was vigorous, grasping and unscrupulous. His learning in medicine was of the old fashion rather than the new, and his anatomical nomenclature was full of Arabisms which the humanists were soon to replace by Greek terms. In this and other ways Berengario denotes anatomy in transition from the medieval world to the more modern one of Gunther, Sylvius, Vesalius and other expositors of the genuine Galen.

Nevertheless, Berengario is an important figure in the history of anatomy, one who would have been more significant if the pace had not so rapidly accelerated in the next generation. He was certainly experienced, even though his claim to have dissected hundreds of bodies must refer to autopsies rather than scientific dissections. New discoveries and important corrections of traditional errors are attributed to him, and he seems to have performed some original experiments to study the working of the body. His illustrations, though few, are superior to all preceding ones. If these and his text pale in comparison with those of Vesalius twenty years later, Berengario and others show that the study of anatomy was proceeding actively long before Vesalius took up the scalpel.

Berengario's chief work was a Commentary (1521) on the fourteenth-century anatomy of Mundinus. In the following year he published a shorter compendium ("Isagogae breves") of human anatomy. This has now been translated by Dr. Lind, who ten years ago printed an English version of Vesalius' "Epitome". Berengario writes as a practical guide to dissection; thus the student is instructed: "Leave the left kidney in its place until the spermatic vessels are examined. Cut the right kidney in its hollow through the middle, examining the place of the vein and of the great artery itself . . . ." Anatomy is accompanied by brief remarks on the temperaments, functions and diseases of the structures described. The approach is direct, and the object the instruction of beginners. Accordingly, Berengario wrote a text lacking all literary charm and speculative interest, which the translator cannot greatly embellish. In fact, Dr. Lind has adhered rather closely to the original, with a result that is stiff and in some places could mislead an unwary reader. A sentence (referring to the chest) such as "The lateral parts are called ribbed and the sides and the region of the breasts" is common enough in Latin but fails to convey any clear meaning in English. Inevitably the translation abounds in technicalities, some those of the modern anatomist, others long disused. It would have been more convenient to the reader (though more troublesome to the printer) to have supplied notes on the page, rather than in two places at the end of the book. From p. 50, for example, there are two notes on the "guidez veins", one (p. 202) by the anatomical annotator Dr. Roofe simply identifying them with the jugulars, and another (p. 185) by the translator explaining the term at greater length. Some of the figures reproduced are very defective and it is not clear whether they are always found in this poor state.

In other respects this volume is handsomely produced and it is very useful to have such a rare and influential work as Berengario's (issued in English as late as 1660, though, of course, seriously out of date by then) made available in a modern translation. It gives a clear notion of the merits and limitations of Renaissance medical science, and one can only wish that the far more sophisticated works of Vesalius and his successors were equally accessible. For this reason Dr. Lind's translation will be valued by scholars and all who have an interest in the development of medicine.

A. R. HALL

EVOLUTION OF BEHAVIOUR

Behavior and Evolution

Edited by Anne Roe and George Gaylord Simpson. Pp. viii+557. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1958.) 80s. net.

SYMPOSIA are very much the fashion; and this is understandable enough since the rate of development of the innumerable divisions and sub-divisions of science has now reached such a pitch that the difficulties encountered by a single author in attempting to synthesize and summarize even a very small field of only one science are almost insuperable. However much we come to depend on abstracting services, reviewing and summarizing journals and the like, we are apt to find ourselves faintly pursuing a rapidly receding objective. Indeed, the rate of movement of some branches of science recalls nothing so much as the recession of the extra-galactic nebulæ—we fear communication will be lost, never again to be re-established.

The volume under review is the outcome of two conferences in which thirty-two well-known biologists participated in the attempt to provide an authoritative report on the significance of behavioural studies for the general picture of animal evolution. Many of the writers refer to the fact that you cannot separate behaviour from the mechanisms of behaviour, and that morphology and the adaptation of structures for particular purposes cannot be divorced from the study of the way in which the animal uses those structures. This means strictly that a volume entitled "Behaviour and Evolution" should cover virtually the whole of zoology, from the palæntological record through genetics, embryology and ecology to ethology and systematics and finally anthropology, ethnology and sociology.

Looked at in this way, it is seen that the subject is one for an encyclopædia or a library rather than a single book. This attempt to cast the net so wide, while it has resulted in the provision of a number of interesting and worth-while chapters, has been detrimental to the book as a unit. Scores of other chapters might well have been written. Thus it is interesting and stimulating to read A. S. Romer on "Phylogeny and Behavior with Special Reference to Vertebrate Evolution", and to learn what is known and what is guessed from the study of structure, of the behaviour of Brontosaurus, the Cephalaspids and other palæontological milestones. But this, after all, is stuff which should be found in the elementary textbook and is of doubtful value as a contribution to a symposium volume. Similar criticisms could be levelled at the chapter on "Food-getting Behaviour" by Marston Bates, on the "Axes of Behavioral Comparison" by Henry Nissen and Carpenter's section on "Territoriality". All are interesting in themselves but all attempt to deal with such a wide and elementary field that the task is an impossible one.

What is in need of modern critical summary is the place of behaviour in relation to genetics, in relation to natural selection and adaptation resulting therefrom, and the contribution of behaviour study to the understanding of such matters as isolating mechanisms and the nature of species and other systematic categories. Taking this more restricted view of the subject, the book has a number of excellent chapters which make very rewarding and sometimes exciting reading. The taxonomic aspects of behaviour study are admirably dealt with in two chapters, one by R. A. Hinde and N. Tinbergen and the other by Ernst Mayr. H. T. Spieth has a stimulating section on "Behaviour and Isolating Mechanisms", showing that while behavioural isolating devices are typically innate, they may also contain important learned elements. A penetrating study of the place of behaviour in adaptation as a result of natural selection is contributed by C. S. Pittendrigh. Here, however, the attempt to synthesize seems to have gone too far. It is argued (1) that all organization is relative and directed towards an end; and (2) that the converse of organization is randomness. From this it follows (3) that everything which is non-random must be directed towards an end; and (4) that complexity, organization and adaptation are in the last analysis recognized by virtue of their non-randomness—both of which statements are surely highly doubtful.

The final section, Part 5, "Evolution and Human Behavior", while containing some most interesting contributions, again falls rather outside any central theme that such a book can have. Simpson, in his introductory essay and his epilogue, makes a valiant effort to pull the whole thing together and produce unity out of diversity: a task beyond even him. I believe a more satisfactory result would have accrued had the contributors been fewer in number, had they had longer in one another's company, and had their discussion (carefully edited and revised) been inserted as links binding the whole together.

W. H. THORPE

LINEAR OPERATIONS AND CLASSICAL ANALYSIS

Linear Operators

By Nelson Dunford and Jacob T Schwartz Part 1 General Theory (Pure and Applied Mathematics a Series of Texts and Monographs, Vol 7) Pp xiv+858 (New York Interscience Publishers, Inc, London Interscience Publishers, Ltd, 1958) 165*s*

THE notion of a linear operator (transformation) is familiar to most mathematicians, but the extremely ramified and elaborate theory of such operators, as presented in the work under review, will come as a surprise to many who have not specialized in this field Part 1 alone of the two-volume work covers 850 pages, including more than 100 pages of bibliography However, many different parts of mathematics, particularly hitherto rather isolated branches of classical analysis, are brought together under the strong unifying influence of the theory, and the mathematician who has grown tired of exploring one peak after another may take comfort in coming upon an edifice which acts like an umbrella covering a vast area

Part 1 presents the topological theory of spaces and operators, and the spectral theory of arbitrary operators (the theory of completely reducible operators is deferred to Part 2) Chapter 1 deals with concepts and results from set theory, topology and algebra, and Chapter 2 with the three basic principles of analysis These consist of (*a*) the principle of uniform boundedness, which involves the result that the limit of a sequence of continuous linear operations is continuous, (*b*) the interior mapping principle, which asserts that in the case of certain spaces continuous linear mappings map open sets on to open sets, (*c*) the Hahn-Banach theorem, which is concerned with the existence of extensions of a linear functional Chapter 3 deals with integration and set functions, and Chapter 4 with twenty-eight spaces (mostly Banach) which occur frequently in analysis These include various sequences and the space of all bounded continuous real or complex functions defined on a normal topological space The notion of convexity in a general linear space is treated in Chapter 5 It is shown how various classes of linear functionals determine topologies in a linear space, including a weak topology in a Banach space Special attention is given to the compactness properties and reflexivity of these topologies, and some fixed point theorems are derived In Chapter 6 linear maps between Banach spaces are studied The notions of adjoint and projection operators and also weakly compact and compact operators are introduced and the basic properties of the operators are obtained Representations of classes of operators are given in the spaces of continuous and integrable functions The concepts and methods of Chapter 7 centre around the idea of the spectrum of an operator Earlier chapters are concerned with topological aspects of operator theory, but function theoretic and algebraic methods are used in the spectral theory Perturbation theory covering changes in the spectrum and the resolvent operator is developed, the basic theorem here being due to Rellich Chapter 8, the last of Part 1, is concerned with applications to semi-groups of operators, functions of an infinitesimal generator, and ergodic theory

A question one might well ask, following upon the presentation of so much theory is What does it do ? The answer is contained in the large number of graded exercises, which, the authors point out, are not 'drill' problems but carrying on the text In fact, they present the applications of the theory to familiar branches of classical analysis, including summability of series (Chapter 2) and integrals (Chapter 4), orthogonal expansions, particularly Fourier series (Chapter 5), and inequalities (Chapter 6) It is interesting to note, and indicative of the power of the theory, that convexity methods, depending largely on the Reisz convexity theorem, may be used to derive many of the most familiar and important inequalities of analysis

"Linear Operators" is encyclopædic in character and will probably become the standard reference text in its field Parts of it may also be used in courses for both undergraduates and those entering upon research In a work of this size material tends to become buried, but there is a detailed subject index which will help to prevent this and the "Notes and Remarks" at the end of each chapter form a very good guide to the extensive literature

L S GODDARD

MATHEMATICS AND OPERATIONS RESEARCH

Mathematical Methods of Operations Research

By Thomas L Saaty Pp xi+421 (London · McGraw-Hill Publishing Company, Ltd, 1959) 77*s* 6*d*

OPERATIONS research, which is now generally regarded as a well-defined field of activity moving in its own right, began life in unusual circumstances The impact of war produced many practical problems, both tactical and strategic, which had to be solved, often within a limited time and with a limited amount of information as data Men, whose basic training had been in different scientific fields, were put together in teams and their task was to formulate and solve the problems inherent in the practical situations at hand The result was highly successful, and thus operations research was born In the post-war years activity has developed greatly on the industrial side In addition, there has been time for a mathematical penetration of the subject to occur, and the use of mathematics in this field forms the subject-matter of the book under review

There are four parts, the first being a discussion of a varied collection of topics, including scientific method, logic, and the building of mathematical models Parts 2 and 3 deal with the more serious mathematical methods of operational research, and cover optimization and programming (both linear and quadratic), the theory of games, probability, statistics and the theory of queueing These two parts form the core of the book and take up about three-quarters of the volume They are well written and will give the graduate mathematician a good introduction to operational research problems and the sort of mathematical methods needed in their solution The chapter on queueing is an excellent summary, and it is a pity that it has not been expanded to deal with the subject more fully One printing error has been detected on p 340 the exponent of μ/λ in the second term of the expression for $P_n(t)$ should be $-n-1$ and not $-n+1$

The fourth part of the book will probably be a surprise to most readers It is an essay entitled "Some Thoughts on Creativity" As the title may suggest, it is largely concerned with the psychology of personality and motivation , creativity, in fact, is defined as "the element of the human personality which provides direction" To the reviewer the essay has proved disappointing, and it seems out of place in a book on mathematical methods The author remarks that "it is difficult to write about general creativity" but has included the essay because it was successful in teaching It would almost certainly increase the value of the book if, in a future edition, the essay were replaced by, for example, a more extended treatment of queueing or production and inventory problems In spite of these remarks, the book should prove valuable both to mathematicians who wish to take up operational research and to industrialists who wish to read something of what operational research can do and how mathematics is becoming more and more an indispensable tool in this field

L S GODDARD

MECHANICAL IMPEDANCE METHODS IN VIBRATION

Colloquium on Mechanical Impedance Methods for Mechanical Vibrations

Presented at the ASME Annual Meeting, New York, N Y , December 2, 1958 Edited by R Plunkett (Sponsored by Shock and Vibrating Committee Applied Mechanics Division) Pp vi+145 (New York The American Society of Mechanical Engineers, 1958) 5 50 dollars

THE basic theory of linear mechanical vibration has been in existence for many years Unfortunately, in some respects that theory is not in a convenient form for use in modern vibration analysis Much effort has therefore been put into re-casting, tabulating, re-examining and extending the known results of vibration theory It has been found very useful in doing this to borrow ideas which have been developed by electrical engineers for use with a c circuits Although it was realized at the beginning of the century[1] that there is such a thing as 'mechanical impedance', the great practical importance of the idea has only become apparent within the past twenty years

There are several ways of developing impedance techniques One may either relate harmonic displacements to a harmonic input force or, alternatively, one may relate velocities to the force , some workers prefer to think of accelerations in terms of harmonic forces In addition, there is the possibility of measuring the displacement (velocity, or acceleration) per unit amplitude of force or of measuring forces per unit displacement (velocity, or acceleration) The upshot is that several schools of thought have come into being Few authors (if any) are prepared to think in terms of more than one of these concepts and consequently the literature is becoming difficult, to say the least

The existence of this rather unsatisfactory state of affairs was the reason for my interest on receiving this work For it is high time that some body such as the American Society of Mechanical Engineers (which sponsored the publication) set about straightening things out Unfortunately, the book fails to do this, although its avowed purpose is "to present the state of the art of impedance methods (by presenting) a survey of what has been accomplished to date"

This book contains a dozen papers, most of which have a good deal of technical interest over a fairly narrow range of the general subject of vibration But there is no attempt to organize the methods used, and indeed more techniques than one are employed in the book I believe that much of this book will be of real interest to practitioners , it will be found wanting by those who are not primarily concerned with specific aspects of vibration analysis but who want to know what impedance methods have to offer

At the risk of confusing the issues still further, I would like to make certain comments on the general subject of impedance methods in vibration theory In the first place, it seems evident that both velocity and displacement techniques are of real practical value Moreover, it is true that, at least to some extent, it is a matter of taste which is adopted (What seems much more debatable is whether one should work with displacement (or velocity) per unit force or force per unit displacement (or velocity)—'admittance' or 'impedance', so to speak) The case for working with acceleration appears to be rather weak

The late H G Yates[2] showed that there are physical reasons for describing the vibratory behaviour of systems in terms of velocity of vibration Incidentally, credit for this is not given in the book although it is a vital contribution in support of the use of the velocity measurements which are favoured by the majority of the contributors

There also appears to be an advantage in using velocity calculations and measurements where high frequencies are concerned (say, more than 500 c /s) High-frequency problems are encountered at the boundary between mechanical vibration and acoustics A great deal of work is being done nowadays on the silencing of machinery in submarines, and here is an excellent example of where impedance methods may very well be superior , this is because of the requirements of acoustical theory, where power transmission must be considered

Many workers advance the existence of an analogy between mechanical systems and a c circuits as being a fundamental reason for using velocities For, by so doing, one preserves the analogy This argument is not as powerful as it may seem, however, since the ability to construct an electrical analogue of a mechanical system implies that the mechanical system is a completely known one Mechanical systems are usually far less tractable than ordinary low-frequency a c circuits But, here again, the velocity approach does come into its own where compound systems, embodying mechanical and electrical components, are concerned

The claims which may be made for displacement methods completely outweigh those for velocity, however, at low frequencies in the vast majority of vibration problems At least this is my opinion For one thing, it is unnatural to think in terms of a fluctuating velocity rather than a fluctuating displacement Physical insight is absolutely vital in the solution of practical vibration problems This is reflected in the book under review in a rather remarkable way , there is no discussion of dynamic instability although this is an obvious field for use of the displacement approach[3]

Another shortcoming of velocities is that they are not as convenient for use in conjunction with Lagrange's equations The matrix equation

$$\mathbf{A}\mathbf{q} + \mathbf{B}\dot{\mathbf{q}} + \mathbf{C}\mathbf{q} = \Phi e^{\lambda t}$$

relating to a system having n degrees of freedom has to be expressed as a form of integral equation if it is couched in terms of generalized velocities ($\mathbf{A}$, $\mathbf{B}$ and $\mathbf{C}$ are the square inertia, damping and stiffness matrices, respectively, $\mathbf{q}$ is a column matrix of generalized displacement and Φ is a column matrix representing amplitudes of generalized applied forces, λ being a complex constant) Some idea of the sheer power of the displacement approach may be had from Duncan's pioneering work[3], much of which has no counterpart in the literature as it relates to the velocity outlook

To be sure, the choice between these techniques is to some extent—perhaps largely—a matter of taste But to regard this as being entirely a matter of taste would be obtuse A critical appraisal of the present position, particularly in the light of recent work in automatic control, is still highly desirable

R E D Bishop

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[1] Greenhill, Sir George, "Notes on Dynamics", 78 (London H M Stationery Office, 1908)

[2] Yates, H G, *Trans N E Coast Inst Eng and Shipb*, 65, 225 (1949)

[3] Duncan, W J, *R and M*, 2000 (1947)

FRICTION IN TEXTILES

Friction in Textiles

By Dr H G Howell, K W Mieszkis and Dr D Tabor Pp xii+263 (London Butterworths Scientific Publications, New York Textile Book Publishers, Inc, 1959 Published in association with the Textile Institute) 42*s*

IN a traditional industry, such as the textile industry, practice has been and, in many aspects still is, ahead of theory This situation has arisen because able men have had an abundance of time to solve technical problems empirically During the past few decades, however, a host of new problems has been presented to the textile industry These problems arise from three main factors the advent of man-made fibres, in both continuous filament and staple form, the increasing cost of labour and the increasing emphasis on, and uniformity of, quality The consequences of these changes are the introduction into the industry of high-speed machinery, of control instruments and of an increasing number of scientifically trained men The Textile Institute is therefore to be congratulated for encouraging the publication, in association with the publishers, of books which relate textile technology to the background of scientific knowledge

The first result of this association is the publication of the book "Friction in Textiles" This book is in three sections, the first one is a readable summary of current views on friction, in which the limitations as well as the successes of current theory are given a just emphasis The second part, entitled "Friction in Textile Processing", contains an account of the special frictional properties of wool, followed by chapters on the importance of friction in the different processes through which fibre passes on its way to the finished cloth It is a measure of the current state of knowledge that all the textile processes can be dealt with in less than sixty pages, compared with twenty-one on the frictional properties of wool and about seventy in the third section of the book, on methods of test

Scientifically and technologically, the middle section of the book is least successful Its value, however, is probably greater for the textile technologist than that of the first and last sections, because it represents a brave attempt to give a coherent account, based on the little data available, of a dominant factor in textile processing, namely, friction The reviewer hopes that textile scientists will read this and be stimulated to carry out the research which is so clearly necessary

ADVANCEMENTS IN METALLURGY

Constitution of Binary Alloys

By Dr Max Hansen Second edition prepared with the co-operation of Dr Kurt Anderko (Metallurgy and Metallurgical Engineering Series) Pp xix+1305 (London McGraw-Hill Publishing Company, Ltd, 1958) 252*s*

Metallurgical Thermochemistry

By Dr O Kubaschewski and E Ll Evans (International Series of Monographs on Metal Physics and Physical Metallurgy, Vol 1) Pp xiv+426 (London and New York Pergamon Press, 1958) 63*s* net

Vacancies and Other Point Defects in Metals and Alloys

A Symposium organized by the Institute of Metals and held at the Atomic Energy Research Establishment, Harwell, Berks, on 10 December 1957 (Institute of Metals Monograph and Report Series, No 23) Pp iii+234+16 plates (London Institute of Metals, 1958) 40*s*, 6 dollars

Vacuum Metallurgy

Lectures presented during the course on Vacuum Metallurgy sponsored by the Department of Metallurgical Engineering in co-operation with the Office of Special Service to Business and Industry, New York University, New York, June 10–14, 1957 (Materials Technology Series) Pp xviii+472 (New York Reinhold Publishing Corporation, London Chapman and Hall, Ltd, 1958) 100*s* net

A Dictionary of Metallurgy

By Dr A D Merriman Pp xv+401 (London Macdonald and Evans, Ltd, 1958) 126*s*.

THE rate of growth of metallurgical knowledge and experience is resulting in a flow of publications covering many diverse fields from many countries and, it must be admitted, of widely differing quality The five books here reviewed are, however, valuable contributions to their own fields of science or technology

The first German edition of Dr Hansen's "Constitution of Binary Alloys" was published in 1936, and immediately gained for itself an honourable place in all laboratories where work on metallic alloy systems was being pursued With the passage of years this edition became progressively less complete and this new and up-to-date one is, therefore, most welcome This second edition is in many respects a completely new work, the text is now in English, the diagrams themselves are plotted on a linear scale of atomic per cent with a non-linear weight per cent scale at the top and the layout of the text is such as to direct the reader to the original literature As before, the diagrams are compiled from what the authors regard as the most reliable work available and regions of uncertainty are denoted by broken lines More attention is given to structural details and reference is made to lattice spacing investigations In its new form this is a quite outstanding publication

Dr Kubaschewski's "Metallurgical Thermochemistry" is in its third edition, and is a book which has clearly filled a real gap in scientific literature, appearing only three years after the second This in itself is sufficient evidence of its quality It is now firmly established as a standard work, and it is pleasing to note the critical assessment which is its characteristic feature. A few alterations in matters of detail have been made to the text of the second edition, and the tables have again been brought up to date

The symposium, "Vacancies and Other Point Defects in Metals and Alloys", is notable for two very distinguished contributions, first a paper by Prof A H Cottrell on "Point Defects and the Mechanical Properties of Metals and Alloys at Low Temperatures," and secondly, one by Dr D McLean on "Point Defects and the Mechanical Properties of Metals and Alloys at High Temperatures". Dr T. Broom and Mr R K Ham review the effect of lattice defects as revealed by studies of deformation and annealing experiments, particularly in relation to stored energy and electrical resistance measurements Dr W. M Lomer gives an elegant review of the defect aspects of solid state diffusion, Dr P L Pratt contributes an account of defects in relation to the mechanical properties of ionic crystals and Mr E C Williams and Mr P C S Hayfield, in what is possibly the least satisfactory contribution, attempt an analysis of surface oxidation processes The discussion of a rather general character is printed in full with illustrations

In 1957, the University of New York organized a symposium on "Vacuum Metallurgy", the twenty-eight papers presented at which are now published The authors, from Europe and the Soviet Union, as well as from America, have covered a very wide field and the importance which vacuum techniques have assumed is abundantly demonstrated It will, for example, come as a surprise to many readers to learn that masses of steel 150 tons in weight are now subjected to such treatment That the newer metals titanium, zirconium, etc, which little more than a decade ago were laboratory curiosities, are now fully fledged engineering materials must in the main be credited to the successful application of vacuum technology On the economic plane, too, it must not be overlooked that, expensive as such techniques are, a vacuum is at times not only the best but may also be the least expensive 'atmosphere' that may be used The scope of the individual contributions includes vacuum equipment and the thermodynamic and kinetic aspects of the subject, melting processes (including a later addition of a paper on electron bombardment melting), degassing in both the liquid and solid states; distillation and other metallurgical applications Special analytical techniques may be required, especially for gaseous impurities, and these are considered, while the final chapter is an attempt to foresee future trends There is an extensive bibliography and an adequate index In assessing this important book, and the adjective is not undeserved, credit should be clearly given to the editor, who has done his job very well indeed

The work required in the production of "A Dictionary of Metallurgy" must have been immense, and although it is, as its name implies, a dictionary and not an encyclopædia, it will be a valuable book of reference on many bookshelves The field of metallurgy is now very wide indeed, and its divisions so diverse, that no one can hope to be conversant with them all Questions outside one's own range of knowledge must at times crop up and such a source of reference as this has, therefore, a value even to a metallurgist of considerable experience To those less well versed in the science and technology of metals it should be even more useful

F C THOMPSON

NUCLEAR ENERGY AND MEDICINE

Medical Sciences

Vol 2 Edited by J C Bugher, J Coursaget and J F. Loutit (Progress in Nuclear Energy, Series 7) Pp viii+288+xii (London and New York Pergamon Press, 1959) 105*s* net

Advances in Biological and Medical Physics

Vol. 6 Edited by Cornelius A. Tobias and John H Lawrence Pp ix+639 (New York Academic Press, Inc, London Academic Books, Ltd, 1959) 16 50 dollars

THE first of these books presents selected papers from the sessions relating to the medical sciences of the Second International Conference on the Peaceful Uses of Atomic Energy held in Geneva in September 1958 The selection has been made mainly from the sessions on radiological protection and the second session on the uses of isotopes in medicine The sessions on biology, physiology and biochemistry are covered by a separate volume

The papers included in this volume may be divided broadly into three groups First there are papers which will be chiefly of interest to health physicists, including two papers on the protection of workers in industrial establishments handling nuclear fuels, with other papers on the detection of ingested isotopes by external γ-ray spectrometry, and on the detection of plutonium in wounds and on the treatment of cases of plutonium ingestion There are also two papers on the metabolism of cæsium-137 and strontium-90

The second group of papers is of more general interest One deals with the lack of any measureable difference in life expectancy of radiologists in Britain and comparable groups of people not occupied in radiological procedures Another concerns the distribution in the incidence of bone tumours in North America in relation to the level of natural radiation, and a third paper deals with the radiation dose required to produce bone tumours, in so far as this can be determined in humans following radiotherapy and also from work with experimental animals

The final group is of more direct medical interest, dealing with various aspects of radiotherapy, including papers on neutron capture therapy, on the use of cyclotron-produced heavy charged particles, as well as on various techniques using γ-ray sources In addition, there is a paper on the mitigation of radiation effects in patients by leukocyte and thrombocyte transfusions and also one on new developments in radiation protection and recovery in experimental animals

The papers selected bear out the opinion of the editors that although few radical advances have occurred in this field since the previous Conference, there has been considerably more thought put into the subjects It is unlikely that the reader will be interested in all the papers presented, but the book as a whole does reflect one aspect of this Conference

The second of these books is the latest volume in this series, published yearly, presenting various topics by leading experts in the fields covered The previous high standard of the series has been maintained and some of the chapters are very good indeed, particularly those of the review type such as the effects of ionizing radiation on tumours in experimental animals, by O C A Scott , ion and water transport in the stomach and intestine, by R P Durbin, P F Curran and A K Solomon , and isotopic tracers in the study of diabetes, by S A Berson and R S Yalow A real attempt has been made by the writers to present these topics clearly and in a straightforward manner Other chapters deal with methods for increasing radiological contrast, radiobiological aspects of the induction of lysogenic bacteria to produce phage, physical and chemical mechanisms of cell injury by ionizing radiation, artificial and induced periodicity in living cells, microspectroscopy of cells, measurement of the regional circulation in the nervous system using a radioactive inert gas, the effect of ultrasound on the nervous system and a very mathematical presentation of the application of light scattering to biological systems

The inclusion of a chapter on fall-out from nuclear explosions which is of such concern nowadays does not achieve the same standard as most of the other chapters The actual mechanism of long-range fall-out over the surface of the Earth, which is now beginning to be understood, receives little attention In considering the biological hazard the author has not succeeded in clarifying this confused and much debated question

The book will be of greatest value in a library where it is available to readers interested in the twelve very different topics covered, but the individual reader may well find the book worth buying for the sake of the wider review articles alone

N M BLACKETT

DERBYSHIRE PLACE-NAMES

The Place-Names of Derbyshire

By Kenneth Cameron Part 1 Introduction, River-Names, etc , High Peak Hundred Pp lxxiv+1–186 Part 2 Scarsdale Hundred, Wirksworth Hundred, Morleyston and Litchurch Hundred Pp vi+187–514 Part 3· Appletree Hundred, Repton and Gresley Hundred, Analyses, Index Pp viii+515–829 (English Place-Name Society, Vols 27, 28 and 29) (Cambridge At the University Press, 1959) 35*s* net each volume

THIRTY-FIVE years ago the English Place-Name Society published its first introductory volume and thereby began its great task of recording and interpreting the place-names of England With the appearance of "The Place-Names of Derbyshire" it has now published the material for twenty counties

In Part 1 of this three-volume work, Dr. Cameron begins with a most interesting introductory essay which shows how place-names may be used to help reconstruct the process and progress of settlement from Roman times onwards Thus, for example, we learn that "A small and remarkable group of [four] names indicates that men of Irish–Norwegian descent also settled in the county" The two places named Ireton both mean "the farm of the Irishman or Irishmen" and contain as a first element the ON *Íri*, the term used of a Viking who had been in Ireland before coming to England or of Irishmen who accompanied the Vikings to England of the two other names in this group, "Mammerton has, as its first element, a Goidelic personal name *Maelmuire*, and Mercaston, a British name *Merchiaun* found in north-west England" Similarly, Dr Cameron also shows that elsewhere the Scandinavian settlers in Derbyshire were mainly of Danish rather than of Norwegian origin

This place-name evidence is clearly of great importance, and it is therefore all the more unfortunate that the six distribution maps of selected place-name elements do not adequately support the text because relevant detail is often omitted, as the map of certain woodland elements shows "The former heavily wooded nature of parts of the county, and the almost complete absence of woodland in others, is indicated in a striking way by the distribution of place-name elements . which are descriptive, either of the woods themselves, or of settlements in woodland" The subsequent elaboration of this statement quite rightly relates the former distribution of woodland to relief and geology— how much more revealing would the map have been if, besides four place-name elements and the main rivers, it had also included a few selected contours and the outcrops of the Carboniferous and Magnesian Limestone and the Millstone Grit

Most of the remainder of Part 1, all of Part 2 and the first half of Part 3 contain the details of the individual names arranged first according to hundreds, then within each hundred in alphabetical order of parishes, and within each parish the more important names first followed by minor names and field-names The extensive use of abbreviations within this section has allowed a tremendous amount of information to be packed into a relatively small compass, and by making frequent reference to the detailed account of the elements to be found in the separate volumes on place-name elements (English Place-Name Society, Vols 25 and 26) still more space has been saved It is unfortunate, however, that, especially with minor and field-names, it has all too often been found necessary to omit any explanation of the meaning of the name For example, of the twenty-five minor names included for the parish of Totley, no explanation is given for a third of these

The second half of Part 3 contains interesting and valuable analyses both of the elements found in Derbyshire place-names and of the different types of names themselves, and these are followed by two comprehensive indexes covering the material in all three volumes

Despite minor blemishes, the work is a monument of patient scholarship and, to all interested in Derbyshire and in place-names, these volumes are indispensable.

I S MAXWELL

A PHYSICAL BASIS FOR LAND USE POLICY IN TROPICAL CATCHMENT AREAS

By Dr H C PEREIRA

East African Agriculture and Forestry Research Organisation, Muguga, Kenya

THE rapid rise in the standard of living of much of the world's population over the past few decades has caused many countries to give anxious consideration to their future water supplies Even in Great Britain the problems of water supply and demand are requiring increasing attention[1] In comparison with the advance of science in other fields the techniques for the study of the water relationships of catchment areas are somewhat undeveloped In the United Kingdom there is much controversy about the hydrological effects of the afforestation of the hillsides the run-off of which supplies the big cities In middle-western States of America the management of natural forests which cover the mountain catchment areas has been the subject of fierce controversy between irrigation, grazing and timber interests

In the high-altitude tropics the development of the forested high ground for production of softwoods and other valuable plantation crops gives rise to similar problems which face the modern administrator with difficult decisions Established facts and techniques are scarce Moreover, they have been derived in a variety of geographical environments and involve many scientific and technological disciplines As a result, trenchant arguments by specialists concerned with limited aspects of these problems cause confusion, and there is growing public concern at the rate at which cities in many countries are outgrowing their traditional water supplies

The basic climatic factors of amount, intensity and seasonal distribution of rainfall, together with the amount and seasonal distribution of evaporation, set the boundaries to these problems Although this is an elementary statement of fact these boundaries are often ignored in arguments seeking to apply findings in one country to problems in another The physical principles are relatively simple The routes by which rainfall, arriving in excess of the prevailing evaporation rates, can reach a stream are classified by hydrological analysts into three categories immediate overland run-off, delayed subsurface flow through the porous soil of the plant root zone, and ground-water flow from porous aquifers beyond the depth of plant roots

The relative importance of these three routes by which rainfall becomes stream-flow is determined by the character of the rainfall distribution In mild climates of well-distributed rainfall, the overland route may be entirely acceptable It is, for example, the principal means of filling many reservoirs in the United Kingdom, where shallow-soiled catchments are, under well-managed sheep pasture, capable of delivering clean run-off water Where reservoir capacity is adequate, infiltration can then be of secondary importance, so that heavily grazed pasture can be a satisfactory catchment area cover

In the colder climates the hydrological performance of mountainous catchments may be dominated by the trapping and storing of snow and by its rate of melting, so that forest management practices become of dominant importance Reservoirs of high capacity are necessary to avoid loss of the snow-melt flood-water which is confined by frozen subsoil to the overland and sub-surface routes

The high-altitude tropics of Africa present a contrasting set of problems Here few of the newly developing communities can afford the very large structures which would be required to store overland flow from the strongly seasonal rainfall Here also the high rainfall intensities cause destructive acceleration of erosion wherever run-off is unchecked Overland flow is thus an entirely unacceptable route, and infiltration is the critical factor for the continuity of water supplies throughout the dry seasons These supplies must depend upon the seasonal recharge of the ground-water reservoirs which maintain spring-flow Fortunately, tropical weathering has produced soils which are very deep and characteristically porous, so that, provided the land use is controlled to secure the maintenance of high infiltration rates at the soil surface, the dry-weather flow can be sustained

These conditions apply throughout most of British East Africa, where the over-riding technical consideration in determining land-use policy for a catchment area must be the maintenance of dry-weather stream-flow Where political considerations, shortage of technical staff, or plain administrative weakness has permitted gross violation of this principle, with consequent destruction of soil resources by overgrazing or by primitive cultivation methods, this is now known beyond doubt to be a short-sighted policy which will impoverish future African generations

Where man has not destroyed it, a continuous canopy of forest covers most of the important high-rainfall catchment areas of tropical Africa within which the major permanent streams arise Determination of the optimum land-use policy for these catchment areas poses two main questions of principle First, is the natural forest the most efficient catchment-area vegetation from the criterion of dry-weather stream-flow ? Secondly, since these well-watered areas of deep fertile soil can be, under modern plantation techniques, among the most productive in Africa, can they also be successfully managed for both stream-flow and agriculture or plantation forestry ? Where territorial income depends primarily on agriculture and forestry, the first priorities for investigation must be the most productive forms of land use

Studies of the performance of large catchments under mixed forms of land use have been shown in the United States to yield relatively little precise information, even when continued over many years To be fully effective, this type of research must comprise intensive measurements of the water cycle during controlled land-use changes on complete catchments, and continuous comparison with adjacent unchanged control catchments If the new land usage is to increase the productive wealth of the territory, then substantial investment of capital and the application of commercial skill and experience are necessary, either through private enterprise or State development This places such schemes beyond the usual resources of the specialist research worker, and indeed the urgency for correct solution of these catchment area problems necessitates the support and active interest of governments at ministerial level.

The immediate questions asked by responsible administrators must be "What will it cost ?" and "How long will it take ?" Experience in British East Africa at present suggests that the costs can be kept very low by combining development of either government or private large-scale enterprises with research into their effects Most of the rich forested catchments are already under Forest Reserve or Crown Land protection, and release of the necessary areas for experimental land-use changes can be made contingent on the preservation of control valleys and the maintenance of agreed schedules for clearing and development

These problems can be solved only by combining the scientific knowledge and experience of agricultural and meteorological physicists, hydrological and soil conservation engineers, foresters, geologists, agronomists, topographical and soil surveyors, and particularly in Africa, by the active co-operation of the administrative authorities The research itself needs only a small team of full-time workers with whom the many technical officers of government departments and of commercial enterprises can co-operate The urgent need that factual information about changes in water regimes should be won while the choice of land-use alternatives can still be made is best appreciated by those most actively concerned with the development of Africa, the ready co-operation of the more enlightened administrators, together with their technical advisers, is therefore the rule rather than the exception

The length of time required to secure a reliable result has, in the past, been a main obstacle to the initiation of this type of research The 'classical' method has been to compare annual stream-flows of pairs of valleys over periods of 10–20 years, in order to provide a statistical basis for subsequent study of a land-use change on one of each pair Since a similar run of years is then needed under the new land use, the time required is inappropriate to countries which have already crowded into fifty years the developments which took centuries in the older temperate-zone communities The classical method is also vulnerable to those extreme spells of departures from average rainfall which can occur by chance without postulation of weather cycles Kerrich[2] has illustrated how successive departures from the average occur by chance in genuinely random data

Fortunately we have most favourable combinations of meteorological and geographical circumstances in the high-altitude tropics which offer facilities for measurement which are unmatched in temperate zone hydrology Our freely drained uniform stone-free soils, usually ascribed to the effects of Pluvial era leaching, have astonishing depths ranging from 10 to 60 ft on many major catchment areas They are underlain, in a few selected areas, by impermeable lava flows Strongly marked wet and dry seasons ensure the substantial depletion and recharge of the soil within the root ranges of forest, pasture or crops These changes are readily followed by occasional extensive deep samplings, linked by the records of electrical resistance tensiometers, they thus afford unique opportunities for the direct measurement of evapotranspiration Based on these periods of direct measurement, the energy balance method of Penman, which has solved the hydrological balance for many catchments in the United Kingdom[3], extends the numerical estimate of evapotranspiration to the complete water year Fully equipped meteorological stations, including radiation measurements, are therefore operated on the site of each experiment The seasonal totals of rainfall, evapotranspiration and stream-flow are thus obtained independently, and the hydrological balance is completed by the measured water storage changes in the first 10 ft of soil, within which the major seasonal depletions occur Changes in the ground-water storage, between the 10 ft depth and the stream, are calculated from the running water budget of the first 10 ft [4] and the measured stream-flow

These favourable circumstances afford opportunities for earlier information on changes in water regimes, the time required to obtain results depending mainly on the rate of development of the new form of land use Mechanical equipment, backed by the large and well-organized labour forces of modern plantation industries, can ensure rapid development[5] Growth-rates, moreover, are high in the tropics so that pastures, tea, coffee, cocoa or softwood plantations rapidly establish their canopies and root ranges, by which their main hydrological effects are achieved In the arboretum of the East African Agriculture and Forestry Research Organization, for example, 6 species of *Eucalyptus* have grown more than 40 ft tall and 5 in in diameter in four years after planting[6] A pasture grass, *Cynodon dactylon*, planted from splits on 8 acres of fallow soil containing 12 replicate profile sets of electrical resistance tensiometers developed roots to a depth of 10 ft in 12 months and heavily depleted the soil moisture to this depth[7]

Four co-operative inter-departmental studies based on these methods are in progress in British East Africa The land-use changes under study are first, the conversion of indigenous bamboo forest to softwood plantations in the catchment areas of the Aberdare Mountains, from which the city of Nairobi draws its water supplies for a quarter of a million inhabitants, secondly, the conversion of indigenous tall rain forest to tea plantations in an area from which the streams supply a well-developed existing tea industry and a large area of African peasant agriculture[8], thirdly, the effects of the opening and closing phases of shifting peasant agriculture in steep mountain valleys as compared with the indigenous forest cover, fourthly, the conversion of over-grazed thornscrub to rotationally grazed pasture, in semi-arid catchments which at present produce only torrent flow.

Only stencilled progress reports have as yet been issued, but detailed analyses of the data of the first two years are now being prepared for publication

These show similar behaviour from dense 40 ft high bamboo forest on the Kinangop Mountain on the Aberdares (lat 0° 45′ S) and from heavy 100 ft high rain forest on Sitoten Mountain in the Lake Victoria catchment (lat 0° 20′ S) Both are at altitudes near 8,000 ft and receive 70 in or more of total annual rainfall In each case infiltration rates are equal to those of the heaviest storms, and no surface run-off is perceptible The first 10 ft of deep porous soil remain continuously wet and evapotranspiration remains at or very near full potential Measurements so far indicate that evapotranspiration rates approach, and are at times fully equal to, those of open water These wet forested valleys are hydrologically more similar to lakes than to usual land surfaces The stream-flow yields differ as a result of the very different ratios of rainfall to evaporation rates, varying from annual totals of 15 per cent of rainfall in the warmest of the valleys to 56 per cent of rainfall in the coolest

In the warmest of these forests, where evaporation is more than 55 in per annum, the soil moisture tension throughout the first 10 ft depth has remained below 1 atmosphere for the 2 years of observations Tension-plate and pressure-plate measurements on undisturbed soil cores have shown a total storage capacity of 20 in of available water in this depth, but periodic sampling has shown that moisture deficits have not yet exceeded 10 in The fluctuations in soil moisture storage have equalled the total annual stream-flow from this 1,750 acre valley, which indicates the importance of the quantitative soil moisture budget[4] in the water cycle An example of the favourable nature of these soils for water measurement is given in Table 1, which compares the moisture contents found by periodic sampling under 'field capacity' conditions with the laboratory determinations made on undisturbed soil cores

This uniformity of physical conditions throughout the soil profile is characteristic of many important catchment areas in East Africa and persists to great depths, up to 60 ft of developed latosol being shown by some borehole records The reproducibility of this measured 'field capacity' permits the calculation of the drainage contribution to ground water[4]

At altitudes of between 8,000 and 9,000 ft the heavy rain forest gives place to a dense cover of bamboo (*Arundinaria alpina*), and in this zone the development of a very large softwood industry is in progress After some 30 years of measurements on sample plots and small plantations by the Kenya Forest Department, the Ministry of Forests has begun large-scale development, designed to provide employment for Kikuyu families displaced by the Mau Mau emergency For ten years the comparative water use of bamboo and of softwood plantations has been studied by this Organization in co-operation with the Kenya Forest Department[9], the evidence has been adequate to indicate that no hydrological ill-effects would be likely to follow replacement of bamboo by softwoods The first major scheme was, however, sited in the catchment area of Nairobi City's future water supplies, and plantation therefore began with the development of experimental catchments

Table 1 FIELD CAPACITY UNDER TALL RAIN FOREST
(A latosol weathered *in situ* from phonolite)

Depth (ft)	Range (in)	Soil cores at tension of 1/3 atm		Sampling results		
		Moisture (per cent dry weight)	Inches of water	April 1958	July 1958	June 1959
Surface	0–6	69 9	2 45	3 08	2 59	2 89
At 1 ft	6–18	62 7	5 02	4 66	4 92	4 82
At 2 ft	18–30	58 0	5 34	5 18	5 29	5 24
At 3 ft	30–42	53 9	5 23	5 41	5 45	5 50
At 4 ft	42–54	56 7	5 39	5 26	5 29	5 41
At 5 ft	54–66	57 0	5 70	5 58	5 74	5 61
At 6 ft	66–78	57 1	5 60	5 48	5 41	5 25
At 7 ft	78–90	55 8	5 58	5 49	5 40	5 45
At 8 ft	90–102	55 4	5 60	5 55	5 60	5 53
At 9 ft	102–114	55 6	5 62	5 82	6 07	5 68
At 10 ft	114–126	57 6	6 05	5 93	5 12	5 95
Total for 10½ ft depth			57 58	57 44	57 88	57 33

Observations are at present near the end of the second 'water year', between successive September–October seasons of minimum stream-flow In 226 wet days of the first water year, a total of 100 45 in of rainfall over the bamboo had kept the soil continuously wet, the electrical tensiometers showing no soil moisture tensions above 2/3 atmosphere between the first and tenth foot depth

Two evaporation pans, one, raised, and the other sunken but air-insulated[10], gave totals of 48 57 and 49 58 in respectively, while the Penman formula, using sunshine hours, gave 54 83 in Sunshine hours give a somewhat inadequate account of the radiation under these typical mist-forest conditions, and substitution in the Penman formula of direct measurements of radiation by the Gunn–Bellani distillation instrument[10] gave an evaporation estimate of 48 82 in , in remarkably good agreement with the pan measurements

The comparison of the forested and cleared valleys is summarized briefly in Table 2

Table 2 COMPARATIVE WATER YIELDS OF BAMBOO FOREST AND FIRST YEAR OF CULTIVATED CLEARING

Annual totals	Valley *C* (161 acres, undisturbed bamboo forest)	Valley *A* (87 acres, cleared and clean cultivated for vegetables)
Rainfall	100 45 in (from 9 gauges)	93 34 in (from 10 gauges)
Stream-flow	56 78 in	65 10 in
Water yield	57 per cent	69 per cent
Water loss	43 67 in	29 24 in
Measured evaporation	49 00 in	49 00 in
Ratio $\frac{\text{evapotranspiration}}{\text{open water evaporation}}$	0 9	0 6

Confirmation that evapotranspiration from this bamboo forest approaches and sometimes equals potential open water evaporation rates has been obtained in the preliminary local experiments, so that the ratios obtained in Table 2 are in accord with previous experience

The saving in water yield was thus about 12 per cent of the rainfall in the first year after clearing This saving was achieved under a clean-tillage form of land use, in which the potatoes, peas, beans, etc , covered only part of the soil surface for part of the time

This is a rather small saving in comparison with the 27 per cent of a 62 in rainfall reported by Hoover[11] as gained by clear-felling a mixed hardwood forest in the colder conditions of the Appalachian Mountains The difference is probably due to the rapid establishment of crops or weed cover under tropical conditions Soil moisture sampling where clear-felling had not been followed by clean tillage showed that the very rapid growth of tall herbs (*Leonotis* sp , *Sambucus abyssinica*, etc) had depleted the first 6 ft of soil by 6 in of water during a severe dry season in the first year after felling[9]

This aspect is sometimes overlooked by engineers in search of increased water supplies Suggestions that water supplies may be improved by felling trees on tropical catchments pre-suppose that an alternative form of vegetation affording equally effective protection from erosion can be economically maintained, from experience with the comparatively shallow-rooted grasses of temperate-zone catchment areas, a grass cover is often strongly advocated

It is planned to change one of the bamboo forest catchments to sheep-pasture in order to make this comparison, but the climax indigenous grass species, which rapidly invades and defeats all others planted in this area, is *Pennisetum clandestinum* or Kikuyu grass A local farming observation at 7,000 ft altitude has been that when a valley which gave rise to a permanent stream was cleared of bush and planted with this grass, the stream dried up and has remained dry for 15 years of permanent pasture Washing out of grass roots showed that they entered decomposed lava at a depth of 19 ft Detailed soil moisture studies to a depth of 15 ft for 5 years in the catchment of the dried-up stream have shown that in each of the two annual rain-seasons the rainfall can be stored in this root range to be transpired during the two dry seasons, so that no surplus is available for stream-flow Kikuyu grass pasture does not, therefore, offer a hydrologically attractive alternative to trees

In addition to food and gainful employment for several hundred Kikuyu families the rotational clear-felling of pine or cypress plantations, followed by clean cultivation of vegetables intercropped between the seedling trees of the next rotation, at present appears to offer the best prospect of increasing water supplies from the mountain catchments of the Aberdares, now under dense bamboo forest

The concentration of rainfall into the tropical wet seasons is so acute that not even the combination of heavy forest and deep porous soils can succeed completely in the even regulation of stream-flow The best catchments under study give ratios of 20 1 for maximum to minimum flow rates When cleared of forests and eroded by overgrazing, some similar East African catchments have given ratios exceeding 3,000 to 1

The work outlined in this paper is progressing as a result of financial support from five East African Ministries and through the personal interest and co-operation of individual technical officers in some fifteen separate departments Together they are making possible the quantitative évaluation of water relationships on which land-use policies for our catchment areas can be soundly based

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FRACTIONATION PHENOMENA IN NUCLEAR WEAPONS DEBRIS

By K EDVARSON, KERSTIN LOW and J SISEFSKY
Research Institute of National Defence, 4th Division, Stockholm 80

As is well known, a chemical fractionation of nuclear weapon debris takes place during the particle formation which occurs within the first few minutes after the explosion A discussion of the particle formation phenomena has been given by C E Adams *et al* [1]

In the present article some studies of the distribution of different fission products in air-borne bomb debris are reported and an attempt to interpret the results has been made

The debris was sampled over the middle of Sweden with a filter-device carried by a jet-plane The filter-medium was glass-fibre-paper (an investigation of the filtering efficiency has been published elsewhere[2]) The sampling took place at an altitude of 8–12 km and the air mass filtered was usually 100–250 kgm

A quarter of each sample was measured by γ-spectrometry and a quarter was autoradiographed The γ-spectrometer consisted of sodium iodide (Tl) crystal ($1\frac{1}{4}$ in diam × 1 in) and a 70-channel kicksorter The autoradiographs have been used to give a general picture of the activity distribution on particles and also as an aid for the isolation of individual particles (cf ref 3) The general trend seems to be that in fresh debris (a few weeks old) a relatively great portion of the activity is concentrated on particles larger than 1μ, whereas in older debris the activity is more evenly distributed on smaller particles

By means of the autoradiographs it was possible to locate the more radioactive particles within some tenths of a mm and these particles could be isolated from most of the remaining activity by punching out a small area of the filter containing the particle In this way a number of samples were divided into fractions each containing particles in a given activity range As a rule two particle fractions named K_1 and K_2 and one fraction consisting of the remainder of the filter (R) were taken (cf Table 1) By γ-spectrometry the content in each fraction of the following nuclides was determined (zirconium + niobium)-95, ruthenium-103, iodine-131, lanthanum-140, cerium-141

The results of the measurements for a number of samples are given in Table 1 At the time these studies were started we had not developed a technique for size-determination of the particles Later on, however, it was possible to make a rough correlation between activity, age and particle size (cf ref 4) In Table 1 the particle diameter limits of the fractions are given

The analysis showed that the compositions of the two (three) fractions from the same filter were different, as a rule in such a way that the K-fractions were strongly enriched in (zirconium + niobium)-95 and impoverished in ruthenium-103 while the other nuclides took a middle position Observations of this kind have also been made by May and Schneider[5] and Sittkus[6]

Table 1

Sample	Size of measured sample (kgm air)	Lower limit of fractions		Number of particles per kgm air	(Zr+Nb)-95		Ru-103		I-131		La-140		Ce-141		Date of sampling	Period of autoradiography	Date of measurement
		pc per particle	μ		pc/kgm air	Per cent	pc/kgm air	Per cent	pc/kgm air	Per cent	pc/kgm air	Per cent	pc/kgm air	Per cent			
117 K R	16 4	60	1 0	1 3	78 123	39 61	6 3 82	7 93	2 9 24	11 89	4 8 58	8 92	29 116	20 80	12 9 57	17–25 9	30 9
119 K_1 K_2 R	12 3	50 3	1 2 0 2	7 0 24	136 84 114	41 25 34	9 3 15 81	9 15 76	(2 0 2 9 11)	(12 19 69)	7 2 12 4 44 5	11 19 70	40 40 111	21 21 58	20 9 57	1–4 10	7 10
120 K_1 K_2 R	23 9	50 3	1 2 0 2	1 4 14	55 25 36	48 21 31	1 3 3 8 17	6 17 77	(0 1 3 5 0)	(0 21 79)	2 9 0 8 10	20 6 74	16 7 3 29 6	30 14 56	27 9 57	1–4 10	10 10
121 K_1 K_2 R	16 6	50 3	1 2 0 2	4 2 19 6	96 37 48	52 20 27	1 7 5 7 36	4 13 83	(0 3 1 3 10)	(3 11 86)	3 8 1 3 15	19 7 74	24 12 44	30 15 55	27 9 57	1–4 10	10 10
132 K R	23 2	30	1 4	2 8	144 263	35 65	0 110	0 100	— —	— —	1 5 15	9 91	12 118	9 91	25 11 57	12–13 12	17 12
136 K R	23 4	30	1 4	1 7	26 149	15 85	0 58	0 100	— —	— —	(0 9) 9 7	(9) 91	3 5 65	5 95	6 12 57	12–13 12	17 12
153 K R	45 5	30	1 9	0 26	4 5 25	16 84	0 64	0 100	— —	— —	— —	— —	0 4 6 6	5 95	24 2 58	25–26 2	1 3
154 K R	20 8	30	1 9	1 1	18 567	3 97	0 7 147	0 5 99 5	— —	— —	— —	— —	1 4 149	1 99	24 2 58	25–26 2	1 3
159 K	174	- -	5	0 006	7 3	100	0 8	100	0 8	100	1 2	100	6 3	100	7 3 58	8–10 3	17 3
161 K R	87 0	90	1 6	0 39	26 22	54 46	1 8 7 2	20 80	4 2 1 7	72 28	7 6 1 9	80 20	20 9 5	68 32	17 3 58	18–19 3	20 3
162 K R	53 0	90	1 0	0 11	9 8 24	29 71	0 9 6 9	11 89	1 8 2 5	41 59	3 0 2 7	53 47	8 4 9 9	46 54	17 3 58	18–19 3	20 3
164 K_1 K_2 R	41 1	90 9	1 6 0 4	0 98 1 7	47 11 62	39 9 52	1 6 1 0 20	7 5 88	4 9 1 7 5 9	39 14 47	14 3 6 7 7	55 14 31	29 7 9 5 5	46 13 41	25 3 58	26–27 3	28 3
166 K_1 K_2 R	19 5	90 9	3 4 1 5	1 1 12	115 82 243	26 19 55	2 1 4 7 65	3 7 90	— — —	— — —	— — —	— — —	9 8 14 82	9 13 78	8 4 58	24–30 6	3 7
167 K_1 K_2 R	47 2	90 9	3 4 1 5	0 17 1 1	28 11 30	40 15 45	0 4 0 3 10 4	4 3 93	— — —	— — —	— — —	— — —	3 4 1 6 12	20 10 70	17 4 58	24–30 6	10 7
168 K_1 K_2 R	19 9	90 9	3 4 1 5	1 7 8 7	262 85 239	45 15 40	3 6 5 1 74	4 6 90	— — —	— — —	— — —	— — —	32 13 87	25 10 65	17 4 58	24–30 6	3 7

(Values in brackets are uncertain)

These findings might be due to two effects One is that the different fractions originate from different explosions, the other that fractionation phenomena have occurred In the first case the youngest fraction ought to have, for example, higher iodine-131/(zirconium + niobium)-95 and lanthanum-140/(zirconium + niobium)-95 ratios than the older If this were the only explanation of the data, the *K*-fractions should in most cases be the oldest As it is almost invariably found that particles of high activity mainly occur during the first months after an explosion this is a rather incredible explanation It seems more probable that fractionation phenomena are the main reasons for the differences in composition In a few samples (zirconium + niobium)-95 was impoverished in the *K*-fractions In these cases it was found from observations of samples taken a few days before and after that this deviation from the normal must be due to an admixture so that the *R*-fraction contained both old and young activity, whereas the *K*-fraction contained almost exclusively the young activity

In most cases it was possible to establish the origin of the debris from known dates of test-explosions and the lanthanum-140-(zirconium + niobium)-95 ratio in the total sample In these cases the values found have been compared with the theoretically expected in the following way A fractionation factor $f_{A\text{-}95}$ for a given nuclide A is defined in the following way

$$f_{A\text{-}95} = \left(\frac{N_A}{N_{(\text{Zr+Nb})95}}\right)_{\text{exp}} \cdot \left(\frac{N_{(\text{Zr+Nb})95}}{N_A}\right)_{\text{theor.}}$$

where N is the activity of the nuclide in question The first bracket contains the experimental and the second the theoretical values, as obtained from known fission yield values if the age is known The yield values for fast fission of uranium-238 have been used, as all the samples in question contained uranium-237, indicating that they originated from thermonuclear devices with uranium-238 tamper The assumed yield values are given in Table 2

Table 2 Assumed Fission Yields for Fast Fission of Uranium-238 (ref 7)

Mass-chain	Yield (per cent)	Mass-chain	Yield (per cent)
95	5 5	140	5 9
103	6 4	141	5 6
131	3 3		

In Table 3 the fractionation factors for the different mass-chains are given As is evident from Table 3 there exists a definite trend in the fractionation factors In the *K*-fractions the fractionation factors increase in the order ruthenium-103, lanthanum-140, (iodine-131), cerium-141 and (zirconium + niobium)-95 and are quite small for the first nuclides in this sequence

It is possible to explain this trend qualitatively from the chemical properties of the elements in the mass-chains at the time of particle formation

As the debris probably emanated from thermonuclear devices it seems reasonable to assume a yield of the order of magnitude 1 Mt In this case the particle formation probably occurs about 15–20 sec after the explosion In Table 4 the element composition of the mass-chains 17 sec after instantaneous fast fission of uranium-238 are given It has been calculated assuming equal chain-length, using the values of Z_A and fractional yield versus (Z–Z_P) given by Grummit and Milton[8], and the half-lives of the short-lived fission-products given by Bolles and Ballou[9] The value of ν has been assumed to be 2

Table 3 Fractionation Factors

Sample	Mass-chain 103	131	140	141	Assumed date of explosion
117 *K*	0 1	0 2	0 1	0 4	22 8 57
R	0 8	1 2	0 9	1 0	
119 *K*₁	0 1	(0 2)	0 1	0 3	22 8 57
*K*₂	0 2	(0 4)	0 4	0 5	
R	0 9	(1 0)	1 0	1 1	
120 *K*₁	0 0	(0 0)	0 2	0 4	22 8 57
*K*₂	0 2	(0 7)	0 1	0 4	
R	0 7	(1 9)	0 9	1 1	
121 *K*₁	0 0	(0 1)	0 1	0 3	22 8 57
*K*₂	0 2	(0 5)	0 1	0 4	
R	1 0	(2 9)	0 9	1 2	
132 *K*	0 0		0 2	0 2	24 9 57
R	0 9		1 0	0 8	
136 *K*	0 0		(0 6)	0 3	24 9 57
R	0 9		1 1	0 8	
153 *K*	0 0			0 3	24 9 57
R	1 1			1 0	
154 *K*	0 2			0 3	24 9 57
R	1 1			1 0	
159 *K*	0 1	0 2	0 1	0 6	25 2 58
161 *K*	0 1	0 3	0 2	0 6	25 2 58
162 *K*	0 1	0 3	0 3	0 7	25 2 58
164 *K*₁	0 0	0 4	0 4	0 6	25 2 58
*K*₂	0 1	0 6	0 4	0 7	
166 *K*₁	0 1			0 3	25 2 58
*K*₂	0 2			0 6	
R	1 1			1 1	
167 *K*₁	0 1			0 5	25 2 58
*K*₂	0 1			0 6	
R	1 3			1 4	
168 *K*₁	0 1			0 4	25 2 58
*K*₂	0 2			0 5	
R	1 1			1 2	

(Values in brackets are uncertain)

Of the elements in question, barium, strontium, yttrium, zirconium form oxides stable at high temperatures with the vapour pressures decreasing in this order Cæsium, molybdenum, tin, antimony and tellurium form volatile stable oxides or are volatile in elemental form From these properties it can be expected that the material condensed at an early stage is enriched in mass-chain 95 and impoverished in 103, 131 and 140, whereas 141 is somewhere between If it is assumed that the large particles in average consist of early condensed material the observed fractionation factors are thus qualitatively explained

From Table 3 it is also found that the fractionation in the *R*-fractions seems to be small

If most of the activity is bound to small particles (< 1μ diameter) at the condensation, the fractionation in the *R*-fraction may well be small although it is

Table 4 Calculated Composition of the Mass-chains 17 sec after Fast Fission of Uranium-238

Mass-chain	
95	20 per cent Sr + 70 per cent Y + 10 per cent Zr
103	5 per cent Nb + 65 per cent Mo + 30 per cent Tc
131	2 per cent Sn + 95 per cent Sb + 3 per cent Te
140	40 per cent Xe + 50 per cent Cs + 10 per cent Ba
141	30 per cent Cs + 70 per cent Ba

appreciable in the K-fractions It should be noted that the particle spectrum in a sample collected a long time after the explosion is quite different from the original due to the change in settling rate with particle size Thus the fact that the K-fractions sometimes constitute quite a large part of the samples does not contradict the explanation given above

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A NEW SERVICE FOR NATURALISTS

By R S R FITTER

Director, Intelligence Unit, Council for Nature

THE Intelligence Unit of the Council for Nature, which was set up in May 1959, with the aid of a grant of £5,000 a year for three years from the British Broadcasting Corporation, is now ready to deal with requests for information about field natural history in the United Kingdom The Unit has a staff of four and maintains contact with active field naturalists and natural history societies in all parts of the United Kingdom, and is especially interested in their field work Some two hundred of these societies are already members of the Council for Nature, and the Unit hopes, before long, also to extend its intelligence system to those societies which are not members

The Unit will act as a clearing house rather than an information bureau and primary source of information It will aim to pass inquirers on to the best sources of information and works of reference, rather than give direct answers to factual queries, though, of course, these will be given whenever possible The sort of queries the Unit hopes to be asked are of the type "Who are the leading experts on the otter or the peregrine falcon in the British Isles ?" or "Who is an authority on the effects of toxic sprays on bird and insect life ?", or 'Who can say what is likely to be the effect on wild life in the vicinity of a nuclear power station on the coast of Suffolk ?' Questions that can be looked up in a work of reference, such as "How long can an otter live ?" or "What is the breeding season of the peregrine falcon ?", will, it is hoped, not be directed at the Unit in too great numbers, as this will stultify the real aim of the service the Unit seeks to provide The Unit will also not expect to be asked to identify specimens (though it will advise on where such help may be obtained), or to give advice relating to pets, domestic animals or cultivated plants

The broader aims of the Intelligence Unit are to build up a picture of the field work being carried out by naturalists all over Britain, ascertain what gaps there are, and put naturalists working on similar problems in touch with each other Among other services which the Unit provides for the Council is the editing of the Council's half-yearly bulletin, "News for Naturalists", the second issue of which is being published in December This bulletin is not for sale, but is available free to member societies and their individual members

The work of the films officer, Stanley Jeeves, covers the whole field of still and ciné photography by amateurs interested in natural history, but to start with is mainly concentrating on the ciné aspects Recently, a most successful experimental beginners' course of instruction for amateur cinematographers was held at the offices of the Council for Nature, in South Kensington Twenty-three 'students' attended and heard talks on technique and equipment by Stanley Jeeves and on the work of the British Broadcasting Corporation Natural History Unit at Bristol, by Tony Soper Afterwards, they watched films taken by three of their number, on vole damage, by Oliver Hook, on waxwings, by J W Carr, and on terns, by F G Hollands

The experimental course was so successful that the Unit plans to organize another one on similar lines in the north of England, perhaps at Manchester, early in the New Year, and possibly also in Scotland There will probably also be a two-day course, with a slightly more advanced syllabus, in London in the New Year, and this may also be repeated in the north A still more ambitious scheme is planned for next May, when the Unit will hold a week's course for amateur cinematographers at Brantwood, Ruskin's Lake District home, which is now run by the Extra-Mural Department of the University of Manchester as an adult education centre. At this course it will be possible to give instruction actually in the field, and to make and edit one or more short films

Another activity of the Films Section of the Unit is the organization of two competitions for amateur cinematographers interested in wild life The first, for 35 mm (and 16 mm at 24 frames) films, is being organized jointly by the Council for Nature and the British Broadcasting Corporation, which has generously offered two prizes, £500 for a full-length 20–30-min film, and £50 for a 3–8-min sequence This competition is not open to those who have already had more than 10 min of consecutive film shown on television The aim of the competition is to stimulate new talent in the field of natural history cinematography, of which, of course, the British Broadcasting Corporation, and especially its Natural History Unit at Bristol, are big consumers

The second competition is for 8 mm (and 16 mm at 16 frames) film, and is primarily for the many amateurs who cannot yet aspire to a 16 mm camera The prizes are being presented by manufacturers of equipment, the first prize being a Paillard Bolex reflex camera worth about £400 Further information about both competitions and the instructional courses can be obtained from the Films Officer, Council for Nature, 41 Queen's Gate, London, S W 7

A further activity on the films side is the compiling of a comprehensive list of natural history films, and more especially those available for public showing. This is being carried out in collaboration with Mr Michael Gwynne and the Botany Department of the University of Oxford

NEWS and VIEWS

Ministry of Aviation Appointments

Dr C H Johnson, C B E

Brief notes referring to promotions in the Ministry of Aviation were printed in *Nature* of November 7, p 1448 , further information is now available

Dr C H Johnson, who has been promoted to chief scientific officer and appointed director of the Explosives Research and Development Establishment, Waltham Abbey, Essex, in succession to Dr W H Wheeler, on the latter's acceptance of an industrial post, graduated from University College, London, with first-class honours in chemistry in 1925 and a Ph D and the Ramsay Medal in 1927 for work under Prof W E Garner concerned with explosive reactions in gases The next two years were spent on research (the chemical and biological effects of ultrasonic energy) and teaching at the University of California He rejoined Prof Garner at the University of Bristol in 1930, initially as assistant lecturer in physical chemistry In 1937 he was appointed senior lecturer in inorganic chemistry in the University of Birmingham, where he continued his researches, begun at Bristol, on co-ordination compounds, particularly those showing optical activity He was awarded his D Sc (London) in 1940 Commencing some months prior to the outbreak of the Second World War, in association with members of the Department of Chemistry of the University of Birmingham, under the late Sir Norman Haworth, Dr Johnson took part in a survey of volatile compounds of uranium and in attempts to isolate uranium metal in bulk In 1942 he joined Shell Refining and Marketing Co , Ltd , and became manager of the Lubricating Oil Laboratory, then in process of formation at Thornton, Cheshire, and later, also, of the Diesel Fuel Laboratory, built in 1946 These laboratories were afterwards incorporated (with two others) in Shell Co 's Thornton Research Centre Dr Johnson entered Government service in 1948 as superintendent of propellant research at the Explosives Research and Development Establishment and became chief superintendent in 1950 Since 1954 he has been director of materials and explosives research and development at Ministry of Supply headquarters in London

Mr W H. Hill

Mr W H Hill has been promoted to deputy chief scientific officer and appointed to the post of deputy director of air armament in the Ministry of Aviation Since 1954 he has been superintendent of the Weapons Assessment Branch of the Armament Research and Development Establishment, where he has been responsible for important advances, particularly in the application of modern techniques to a field of increasing complexity and importance in armament development Mr Hill obtained his degree at the University of Cambridge Following some four years on the academic staff of the University College of the South West, lecturing in applied mathematics, he spent the period 1941–46 in war service, retiring with the rank of major in the Royal Electrical and Mechanical Engineers, and in 1946 joined the scientific staff of the War Office, serving first with the Army Operational Research Group and later on the staff of the Scientific Adviser to the Army Council He was transferred to the Ministry of Supply in 1952 and spent some eighteen months in the Guided Weapons Department of the Royal Aircraft Establishment before his promotion in 1954

Mr S A Hunwicks, O B E.

Mr S A Hunwicks has been promoted to deputy chief scientific officer and appointed director of Atomic Weapons (Development), Ministry of Aviation He started his career in 1930 in the Department of Engineering at the National Physical Laboratory, where he worked mainly on the strength of materials at high temperatures and lubrication problems In 1934 he graduated in engineering at London In early 1939 he joined the Armament Department of the Royal Aircraft Establishment and gained a wide experience on research, development and design of airborne weapons From 1943 he was responsible for full-scale trials on airborne rockets, including development of techniques for measuring air and underwater ballistics During this period he initiated and carried out the establishment of several Royal Aircraft Establishment ranges, including Lake Alwen in North Wales In 1946 Mr Hunwicks was one of the Ministry of Supply scientific team seconded to the Department of Supply, Australia, for the setting up of the Long Range Weapons Establishment at Salisbury, South Australia, and the Woomera Range His special responsibilities were air facilities, the bomb ballistic range which was the first range operating at Woomera, and staff recruitment On returning to Great Britain, he rejoined the Armament Department, Royal Aircraft Establishment, in 1949, becoming section head responsible for the design and development of special weapons In 1954 he attended the Administrative Staff College, and shortly afterwards was promoted to superintendent in the Armament Department responsible for the co-ordination of all Royal Aircraft Establishment work on free-falling weapons

Mr A N Christmas

Mr A N Christmas has been promoted to deputy chief scientific officer and appointed director of Guided Weapons (Techniques) at the Ministry of Aviation Headquarters Mr Christmas graduated with first-class honours at the University of London in engineering in 1933, and after a period of research in industry joined the government service in 1937 as an assistant engineer in the Radio Branch of the General Post Office Engineering Department In 1946 he was attached to the Ministry of Supply for work at the Royal Aircraft Establishment on control systems for guided weapons In 1947 he transferred to the Ministry of Supply and continued his work on guided weapons at the Royal Aircraft Establishment until 1951 when he was posted to the United States and for three years was a member of the Ministry of Supply staff at the British Joint Services Mission in Washington During this time he was responsible for liaison work covering the whole field of guided weapon research and development in the United States In 1954 he was promoted to senior principal scientific officer and returned to

Great Britain to take up the post of superintendent of the V.T. Fuze branch of the Armament Research and Development Establishment. In his new post Mr. Christmas will be responsible for directing research and development on guided weapons techniques, including guidance and control, propulsion and advanced engineering techniques specially applicable to guided weapons.

British Contribution to High-Altitude Research

IT was decided at a meeting of the International Committee on Space Research in the spring that great scientific value was to be gained from the simultaneous, or nearly simultaneous, firing of many rockets in different parts of the world carrying identical or related experiments. It was hoped that all countries participating in high-altitude research with rockets would launch one or more, the elucidation of atmospheric structure being a particular aim of the experiments. The British contribution has been developed jointly by the British National Committee on Space Research set up by the Royal Society and the Royal Aircraft Establishment of the Ministry of Aviation, and consists of experiments carried by the upper-atmosphere research rocket *Skylark*. This rocket is powered by the Raven solid-propellant motor designed by the Rocket Propulsion Establishment, Westcott. The rocket is launched with the co-operation of the Weapons Research Establishment at Woomera in Australia. The programme was to launch three rockets, and these were all fired in the space of 36 hr. on November 30 and December 1.

The first *Skylark* carried the sodium vapour experiment devised by the Queen's University of Belfast. Sodium vapour, ejected from the rocket at heights greater than about 40 miles, gives a resonance glow when observed under the correct twilight conditions. Optical observations of this glow, made with an interferometer and with ballistic cameras, can give data leading to both atmospheric temperature and wind structure. The second *Skylark* was to measure the atmospheric temperature and horizontal and vertical wind speeds up to heights of 90 miles using a sound-ranging method. This is based on the optical and acoustical observations of explosive grenades, ejected from the rocket at regular intervals. This experiment is the responsibility of a group at the Physics Department, University College, London. In addition, metal foil was ejected from the rocket and observed by radar, enabling an independent estimate of wind speed and direction to be made by a group at the Department of Meteorology, Imperial College of Science and Technology, London. The third *Skylark* carried three experiments: measurement of atmospheric temperature and horizontal and vertical wind-speeds using the grenade sound-ranging method (University College, London); measurement of wind characteristics by using radar observations of metal foil ejected from the rocket (Imperial College, London); and measurement of electron densities in the ionosphere (Department of Electron Physics, University of Birmingham).

New Australian Botanical Laboratory

THE new Australian Commonwealth Scientific and Industrial Research Organization's Cunningham Laboratory, which was recently opened by the Prime Minister of Australia, Mr. Menzies, occupies a three-acre site in the grounds of the University of Queensland at St. Lucia, a suburb of Brisbane. It was completed this year at a cost of £180,000. The Government of Queensland provided the site, contributed £15,000 towards the cost of the building, and built the access roads at a further cost of £10,000. The work of the Cunningham Laboratory is particularly concerned with pasture improvement in four regions known as the Wallum, the Spear Grass Zone, the Brigalow Scrubs, and the Darling Downs. These regions constitute an area of about 70 million acres, which is considerably larger than the State of Victoria. Officers of the Division of Tropical Pastures (the main group housed in the Laboratory) hope to introduce a number of new grasses and legumes into Queensland pastures. Plant collection officers who understand Queensland conditions have already collected promising species from South America, Africa, Hawaii, the United States, India, Ceylon, Mexico, the West Indies and Central America.

Preservation of Cornish Scenery

THE Minister of Housing and Local Government has confirmed an order made by the National Parks Commission under the National Parks and Access to the Countryside Act, 1949, which designates about 360 square miles of Cornwall as an "area of outstanding natural beauty", and not as a national park. The designated areas include some of the finest and best-known coastal scenery in Britain, and Bodmin Moor. A large part of the Land's End peninsula, a coastal strip from St. Michael's Mount to Porthleven, and the whole of the Lizard peninsula, including the beautiful Helford Estuary, to the outskirts of Falmouth are covered by the order, while other parts of south Cornwall included are the territory between St. Mawes and St. Austell, the Fowey Estuary to West Looe, and Rame Head to Mount Edgcumbe, overlooking Plymouth Sound. In north Cornwall, the whole of the coast between the Devon–Cornwall county boundary, at Marsland Mouth, and Bedruthan Steps, north of Newquay, is included, apart from an area around Bude and part of the Camel Estuary between Polzeath and Padstow. The order also covers the coast from Perranport to south of St. Agnes Head, and between Portreath and Godrevy Towans. The responsibility for preserving and enhancing the natural beauty of the landscape rests with the local planning authority, Cornwall County Council. Government grants can be made at the rate of 75 per cent towards the cost of treating derelict land, tree-planting and preservation, and removing disfigurements. Grants are also available towards expenditure incurred in making agreements or orders for public access to open country and in appointing wardens. Designation does not provide any right of access to land not already open to the public; nor does it affect the existing use of land, for example, the use of War Department land for military purposes.

Darwin Centenary

FOR the first time, a number of the *Notes and Records of the Royal Society of London* has been devoted to a single topic (14, No. 1; June 1959). Its main purpose is to celebrate the centenary of the publication of "Origin of Species", and this has been done most adequately. It contains a fascinating collection of unpublished letters of Charles Darwin as well as an article on A. R. Wallace which, *inter alia*, directs attention to his essay of 1855; this hitherto appears to have escaped notice. There are also biographical sketches of the four men who probably had most influence on Darwin—Erasmus Darwin, Lyell, Hooker and Malthus The essay on Malthus by Prof H J Habakkuk is of special interest and shows how, with his writings on population, Malthus provided the clue to the origin of the species both for Darwin and for A R Wallace This special copy of *Notes and Records* was designed to pay tribute to Darwin, and in itself is a tribute both to him and the Society which sponsored it

Education as a Career

THE Ministry of Education has published a pamphlet intended to give university students a picture of the opportunities which exist for men and women to follow a career in education ("A Career in Education for University Graduates" Revised edition Pp 15 London Ministry of Education, 1959) It describes the training and types of work open to university graduates who become schoolmasters and schoolmistresses, with particular reference to work in grant-aided schools It also refers to the financial aid available towards the cost of training The appendixes which follow give up-to-date facts about teachers' salary scales in schools and about teachers' pensions They also include some information about opportunities for teaching in establishments of further education and training colleges, and for work in local educational administration and H M Inspectorate There are also opportunities for educational work in a variety of other spheres, both in Great Britain and abroad, and some of these are described.

Handicapped Children

THE thirteenth in a series of special subject booklists prepared for the Library Association deals with handicapped children in Britain ("Handicapped Children in Britain—Their Problems and Education" Books and Articles published in Great Britain from the 1944 Education Act to 1958 Compiled by Mrs W A Axford Pp 53 London . Library Association, 1959 4*s*) The compiler, Mrs W A Axford, of the University of Birmingham Institute of Education, deserves the warmest praise for a painstaking task well done , the list includes details of books and articles published in Great Britain from the 1944 Education Act to 1958 The bibliography covers all types of physical and mental handicap, but not psychological or social handicaps Articles of a purely medical nature are excluded unless they are of general interest For easy reference the items are arranged in alphabetical sequence of subject headings

Film Strips for Schools

DESPITE the exciting potentialities of moving films and television as means of evoking interests in schoolchildren, the teaching profession as a whole regards the still picture as an even greater aid to teaching The moving picture awakens interest and captures attention , teachers use still pictures to ensure that factual knowledge is retained For this reason, they will once again be grateful to the enterprising firm of Educational Productions, Ltd , for adding four more attractive and inexpensive coloured film-strips to its wide range One, showing a variety of common garden insects, has been prepared by the well-known photographer, George Hyde, and would be of interest to horticultural clubs as well as in school biology classes "Resident British Birds" has been prepared in collaboration with the Royal Society for the Protection of Birds , the photographs are by Eric Hosking and the script by Philip Brown "Grasses" would be of particular use in sixth form and university botany classes, while "Seed Germination" should find a warm welcome in secondary modern, secondary grammar schools and others where biology is taught to the General Certificate of Education, 'Ordinary' level (Educational Productions, Ltd Filmstrip No 5260 Insects in the Garden 28 frames 16*s* 6*d* Filmstrip CX 6290 Seed Germination 23 frames 27*s* 6*d* Filmstrip CX 6332 Grasses 27 frames 27*s* 6*d* Filmstrip CX 6208 Resident British Birds 33 frames 27*s* 6*d* East Ardsley, Wakefield Educational Productions, Ltd , 1959)

Evolution of the Human Brain

THE James Arthur Lecture on the Evolution of the Human Brain, given by Prof D P C Lloyd, entitled "The Discrete and the Diffuse in Nervous Action", has now been issued (pp ii+28 New York Amer Mus Nat Hist , 1959) His central theme is Cajal's concept of "les réflexes unilatéraux circonscrits" and "les réflexes unilatéraux diffus" Much of Prof Lloyd's work has been concerned with the functional implications of the anatomical distinction made by Cajal , and in this lecture he elaborates the idea that the circumscribed monosynaptic reflex is an accurate, rapid and discrete functional arrangement of advanced evolutionary status On the other hand, the diffuse reflexes involving interneurones constitute an organized, although more plastic, system for synergic mass actions The latter are to be distinguished from the primitive mass action systems of many invertebrates by the 'local sign' they exhibit in performance There is little in this theme that is controversial, and much that can now be considered as consolidated in physiological thought but Prof Lloyd, as the author of a substantial part of the experimental evidence, develops the theme with great clarity and point

Fodder Beet, Mangels and Swedes

REVISED leaflets describing varieties of fodder beet and mangel and of swedes have recently been issued by the National Institute of Agricultural Botany at Cambridge In each of these crops the Institute has tested very large numbers of varieties, and these leaflets give details of the important root characters, the size of top and percentage bolters of the varieties which have proved most successful in the trials These leaflets give the farmer the information he needs to make an intelligent choice from the bewildering range available Copies can be obtained by sending a stamped addressed envelope, saying which leaflet is required, to the Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge

Announcements

THE honorary officers and members of Council of the Association of Consulting Scientists for 1959–60 are *Chairman* Dr J G Davis , *Hon Treasurer* Dr G W Ferguson , *Hon Secretary* Mr W H Stevens, Park House, Hawthorne Road, Bromley, Kent , *Members* Dr M Barent, Dr H H Chambers, Dr J Grant, Dr J H Oliver, Mr. O W Roskill and Mr F. G Sarel Whitfield

ERRATUM In the communication entitled "A New Crystalline Salt of Oxytocin" in *Nature* of September 26, p 981, par 3, line 4, for "33 mμ" read "353 mμ"

PROGRESS IN COKE RESEARCH IN GREAT BRITAIN

AN established annual event is the joint meeting of the Coke Oven Managers' Association, the Institution of Gas Engineers and the British Coke Research Association These three institutions cover the technical interest of the carbonizing industries in all its facets This annual gathering has become noteworthy for the fact that some matter of absorbing interest is discussed at the meetings

It will be recalled that in the autumn of 1958 the Duke of Edinburgh opened the new Coke Research Centre of the British Coke Research Association at Chesterfield A special feature of this research station is that it contains, besides chemical and physical laboratories, a large workshop laboratory for pilot-scale plant, an excellent information centre, and a full-scale plant for making coke and its by-products This last feature was a bold venture, which had been in the minds of the practical men of the industry for upwards of a decade

At this year's tripartite meeting, held recently, the director of the Research Association, Mr G W Lee, gave an encouraging account of the work that had been carried out during its first year at the Coke Research Centre Naturally, everyone was interested to hear how the full-scale plant had operated in practice, for the coke-oven manager knows full well the teething troubles that may be expected to be encountered in such an undertaking Mr Lee was able to unfold a story of quite substantial success

The coke oven is to be used for producing sufficient coke to enable performance trials to be made of the resultant cokes in production blast furnaces One cannot use less than a hundred tons of fuel for trial on an industrial unit of such magnitude There is also a by-product plant to deal with the collection of tar and other products distilled from the carbonizing coal in the oven To overcome all the teething troubles successfully in the coldest period of the year when there was 17° F of frost—and incidentally seventeen coke braziers required—was no mean achievement To train also the composite team of operators, having both technical ability and practical experience of plant operation, to run the plant had been a problem in human relations It has to be remembered that the plant was quite unique, and the carbonizing of each charge of coal a huge scientific experiment calling for accurate instrumentation, measurement of numerous values and precise analysis In the upshot, the standard of repeatability of yields achieved was good, and in the final runs reported 'very good', in Mr Lee's modest claims, we should say, in such demanding conditions, excellent

Perhaps the most satisfactory outcome of these trials was to prove that the results of full-scale trials confirmed the usefulness of trials in smaller experimental ovens, a range of which the Association has for long been using Such a situation makes for accelerated progress in the matter of producing still better qualities of coke from coals of diminishing suitability for the purpose, as the reserves of coking coal of good quality become depleted

The Coke Research Association has established, as have other research associations in Britain, a world-wide reputation for the quality of its research In the new Research Station the equipment and the staff are such that the good work can be continued at an accelerated pace 40 per cent of its research effort is devoted to improvement in the quality and yield of coke, and 11 per cent to the thermal behaviour of coal and the fissuring of coke The remainder is concerned with a wide range of fundamental and applied studies that the future welfare of the industry demands

The layman is rightly concerned about the pollution of the air and of the rivers which industrialization carries in its train These subjects have not been overlooked The effluent problem in the coking industry has many features in common with that of the gas industry, and accordingly these industries have joined forces in tackling the water pollution problems that arise from their activities The Coke Research Association is supporting both financially and technically the work of the Joint Research Committee and the University of Leeds through its Ammonia Effluents Sub-committee

As regards the field of atmospheric pollution, investigations of the Coke Research Centre have included preliminary studies of the chemical and physical nature of the smoke emitted from a coke oven Naturally, problems of suppression are also being studied

All these matters that concern the future prosperity of the coal industry contain reassuring features of particular interest to those enlightened sections of the British public which already recognize that the future of coal must depend upon the technological effort put into its utilization

SOIL SALINITY COURSE IN TUNISIA

FOLLOWING an invitation of the Government of the Republic of Tunisia and with its sponsorship, Unesco's Middle East Science Co-operation Office organized a Regional Training Course on Diagnosis, Improvement and Management of Salt-affected Soils as a part of the Arid Zone Project The course was held in Tunis during September 7–October 3, 1959 It consisted of one week of lectures, followed by two weeks of laboratory work and a field trip to the arid regions and saline soils in Tunisia

The chemical aspects were treated by Dr A D Ayers, formerly with the U S Salinity Laboratory, Riverside, California, now with the Agricultural Research Service U S Department of Agriculture, Rome, the geological and pedological aspects by Prof G Aubert, Institute of Tropical Soil Investigations, Office for Technical and Scientific Research for France Oversea, Bondy, France , and the physical aspects by Prof W R van Wijk, Agricultural University of Wageningen, Netherlands Dr Ayers served as general technical director

Reclamation of saline soils and use of saline water for irrigation are problems of primary importance in Tunisia This was stressed by the President of the Republic of Tunisia, Habib Bourguiba, who opened the conference and welcomed the group Prof Kovda, director of the Unesco Department of Natural Sciences and one of the foremost Russian soil scientists, thanked the president on behalf of Unesco Prof Kovda stayed at Tunis during the first week of the course He and several French scientists, consultants to the Tunisian Government, gave lectures on special subjects as capillary rise of saline ground water, genesis of saline soils, Tunisian soils, plant associations in Tunisia, crop research in Tunisia, distribution and quality of surface and underground waters in Tunisia The Secretary of State for Education, Mahmoud Messadi, the Secretary of State for Agriculture, Abdessalam Kenani, and many other Tunisian authorities attended at one or more lectures

The lectures and laboratory work were held in the Ecole Supérieure d'Agriculture (director Prof Haffani), where also the participants were housed There were thirty-two participants from ten Middle East countries Of these, fifteen were from Tunisia, the others from Iran, Iraq, Jordan, Lebanon, Lybia, Morocco, Sudan, Turkey and the United Arab Republic Most of the participants were graduate staff members of universities or research institutes and several held responsible positions in their countries The enthusiasm and interest of the participants contributed much to the success of the course

The field trip was offered by the Tunisian Ministry of Education Leaders were Prof G Aubert and Mr Roederer, head of the Pedological Service of the Ministry of Education First the Medjerda valley was visited where an ambitious and magnificent project of reclamation, land amelioration and irrigation is in progress Thereafter the arid and desert areas in the south were visited where a variety of soils of different degrees of salinity were studied The capriciousness of the weather and the statistical meaning of the concept of climate were convincingly demonstrated on that occasion A heavy thunderstorm caused a delay of several hours before the 'Landrovers' could cross the flooded parts of the route Kairouan–Gafsa (annual precipitation between 4 in and 8 in) and the main road Gafsa–Tozeur was badly damaged From Tozeur the field trip went to Kebili and Gabes, crossing the famous salt marsh of Chott el Djerid The plans were to visit the fast saline area around Gabes Again, however, a heavy thunderstorm interfered The expedition was practically isolated for two days in Gabes as the environments were flooded, and then had to return to Tunis

This note on the Salinity Course would be incomplete if no mention were made of the hospitality which the participants and in particular the Unesco instructors received from officials and private persons, Tunisian as well as French On such visits the impressive achievements but also the still remaining problems of the young Republic in the fields of education, public health, organization and employment of labour were frankly discussed

W R van Wijk

THE NATIONAL CHEMICAL LABORATORY

THE Report of the National Chemical Laboratory for 1958 follows the same general lines as previous reports (Department of Scientific and Industrial Research Report of the National Chemical Laboratory, 1958 Pp iv+97 London H M Stationery Office, 1959 5*s* 6*d* net) After a preliminary statement that the name of the Laboratory has been changed to indicate more precisely its true functions and that a steering committee is now responsible for the research programme, the Report sets out the various lines of work on which the Laboratory has been engaged Broadly speaking, these fall into six main groups the extraction of metals, the preparation of pure elements and compounds and the determination of their properties, the corrosion of metals, the development of new materials, analytical research and services, and microbiology Some at least of these divisions have been represented by work in the Laboratory over a period of years, that on the corrosion of metals being a special case in point Each year, however, new problems have come forward and as a result it appears that the staff of the Laboratory is now much larger than it was formerly

In addition to its own work the Laboratory has for some years maintained an advisory service Each year numerous inquiries are received for advice and assistance on all topics related to its own work, particularly such as concern the corrosion of metals and the purification of organic compounds In addition, the Laboratory is often approached for advice on topics quite outside the scope of its researches One example mentioned in the field of corrosion is that of the pitting of domestic copper piping in a housing scheme, and others show that this advisory service must be a valuable feature of the general activity of the Laboratory and that the problems coming in through it may sometimes prove very suggestive and important in relation to its own work

The parts of the Report dealing with corrosion show that some fundamental work on the mechanism of corrosion is proceeding alongside investigations on various aspects of more directly practical interest, such as those on inhibitors Work on the extraction of metals included studies of the extraction and recovery of uranium from a variety of ores, which is of interest to the United Kingdom Atomic Energy Authority, and on the separation of the rare earths Of special interest is the section of the Report dealing with the preparation and properties of pure elements and compounds In the case of metals it has long been known that the presence of even minute traces of impurities, sometimes so small as to prove extremely difficult to detect by ordinary analytical procedures, can lead to profound changes in properties such as hardness and chemical activity The increasing importance of pure metals in modern metallurgical technology makes this part of the work of the

Laboratory of great interest The zone-refining technique has necessarily played an important part

The section of the Report dealing with the development of new materials is largely concerned with ion-exchange resins and the permeability of membranes This part is written up in rather greater detail than the rest of the Report and hence makes interesting reading The underlying ideas are more carefully presented, and there are good graphs of the results As a general criticism it might be said that a good deal of the rest of the Report is presented so briefly that it cannot arouse much interest except among specialists, but the part on new materials does seem to have achieved something in this direction It would be unfair to contrast with this the eleven-page catalogue of strains of bacteria at the end, but the different parts of the Report vary quite considerably in appeal to the non-specialist scientific reader, and perhaps in future greater attention could be given to this aspect It has obviously been a difficult problem for the director and his staff to compress their material into pre-ordained limits, but a tendency to produce information as from one specialist to another has cramped the style in some cases

The general work in the Laboratory now includes emission and infra-red spectroscopy, micro-analysis and polarography The first two might seem to encroach to some extent on the field of the National Physical Laboratory, but the researches are evidently directed towards chemical problems Some work on various compounds of boron is of interest although it seems to have been limited to organic compounds The immediate aim, it is said, has been to provide background knowledge of the chemistry of the boron–nitrogen system and to prepare a range of intermediates from which thermally stable and other useful materials may be made The general impression conveyed by the Report is that inorganic chemistry, which has now become of extreme importance, has perhaps received less attention than it should do, and the metals have, perhaps understandingly, monopolized a large share of the interest in the field

The Report as a whole is a record of work of great value, but with the extension of staff and work the question must arise whether it is now possible to cover the results in an interesting and understandable way in less than a hundred pages It is true that much of the work will ultimately be published in a more extended form, but it will then tend to be lost in the enormous field of specialist literature It might be worth considering whether the Report could be enlarged to double its present size (and, of course, at greater cost to the purchaser) and an attempt made at the same time to deal with topics of wider interest in a way which would attract the general scientific reader J R PARTINGTON

MUTATION OF BACTERIA AT HIGH LEVELS OF SURVIVAL BY ETHYL METHANE SULPHONATE

By ANTHONY LOVELESS
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AND

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ETHYLATION was first described as a mutation-inducing process ("alkylation of the gene molecule") by Rapoport[1], who used diethyl sulphate as the reagent and *Drosophila melanogaster* as the test material Subsequent work has revealed that ethylating agents appear to have unique properties as mutagens in a number of systems Thus, treatment of phage *T*2 *in vitro* by either diethyl sulphate or ethyl methane sulphonate results in a considerably increased yield of both plaque-type and host-range mutants in the first cycle of infection by the treated phage of untreated cells of *Escherichia coli* strain *B* (ref 2) and strain *B*/*r* (Loveless, unpublished) No other alkylating agents have so far been reported as sharing this property Heslot *et al* [3] have reported that the yield of mutants afforded by barley seeds treated with ethyl methane sulphonate much exceeds that of seeds treated with a wide variety of other alkylating agents , diethyl sulphate, also, was found to have unusual properties[4] Kølmark[5] found that diethyl sulphate provoked an appreciable number of reversions at an inositol locus of *Neurospora* which had proved relatively intractable to other reagents There is no evidence from the results of the Fahmys[6] of any dramatic mutagenic effect of ethyl methane sulphonate in *Drosophila* in comparison with its homologues, but it is probable that this compound was not tested at the high doses which its low toxicity, as measured in other organisms, might be expected to permit D M Green (personal communication) has reported confirmation of the results with *T*2 phage and an extension of the finding to *T*4

There was thus reason for supposing that the unusual genetic effects of ethylation were widespread in the organic world, and we were accordingly prompted to investigate the mutagenic effect of ethyl methane sulphonate upon bacteria We wish now to report the production, consequent upon treatment with this compound, of high yields of revertants of a cystine-requiring mutant of *Salmonella typhimurium* strain *LT*2 and of mutations to phage *T*6-resistance in *Escherichia coli* strain *B* and *B*/*r* In addition, preliminary experiments yielded five auxotrophic mutants of *S typhimurium* strain *LT*2 out of 1,090 colonies tested, each having a different nutritional requirement

(1) *S typhimurium* strain *LT*2, *cysA*-21 [7] (requiring cystine) was grown in synthetic (*M*-9) medium plus cystine at 40 µgm /ml from a 1 100 inoculum from an overnight culture in the same medium At approximately 2 × 10^8 cells/ml the culture was spun, washed in *M*-9 medium lacking cystine and resuspended at *c* 10^{10}/ml in a small volume (*c* 3 ml) of 0 4 *M* ethyl methane sulphonate for 15 min treatment at 37° C (Survival tests carried out independently showed that this treatment left about 70 per cent viable cells , in the mutation experiments the actual recovery was only 10–20 per cent owing,

at least in part, to losses in centrifugation Since the treatment was given by re-suspending a centrifugal pellet with residual buffer, the final concentration of ethyl methane sulphonate was probably nearer 0 35 *M* Care must be exercised in the use of ethyl methane sulphonate and some other alkylating agents[8] at concentrations nearing saturation since toxic effects other than those due to alkylation may become pronounced (Ethyl methane sulphonate is saturated at about 0 5 *M*) At the end of the treatment the suspensions were diluted tenfold into phosphate buffer to minimize further action, re-spun and re-washed to remove ethyl methane sulphonate, and plated on minimal medium enriched with 0 01 per cent dehydrated 'Difco' broth (*c* 1 5 × 10^8 or 1 5 × 10^7 cells per plate), and at appropriate dilutions on minimal-plus-cystine medium and on broth agar Control plates were made similarly from the re-suspended cells before the last centrifugation prior to treatment

Revertant colonies, that is, colonies non-exacting for cystine, were of two main types large colonies assumed to be due to back-mutation, and small colonies attributable to partial reversion, phage grown on the latter was able to transduce the mutant strain *cysA*-21 and other mutants of the same group to a 'small-colony' form By analogy with similar revertants of this strain previously analysed[9], they may be interpreted as being due to suppressor mutation The results are given in Table 1

Table 1

	Total viable cells plated	Large-colony revertants	Small-colony revertants
Untreated	5×10^8	5	18
Treated	10^9	1,094	47,110

The counts were made after four days incubation The total viable cell value is based upon colony counts on minimal-plus-cystine plates, since these were higher than upon broth agar

(2) *S typhimurium* strain *LT*2 (wild type) was handled as above except that it was grown in minimal medium without cystine and plated ultimately on nutrient (broth) agar Replica plating on to minimal medium revealed 5 auxotrophic colonies out of 1,090 printed These were checked by re-streaking on both media and by testing for sensitivity to phage *PLT* 22 strain *H*5 All five were transducible to prototrophy by phage *PLT* 22 grown on wild-type cells Four of these have been identified as requiring histidine, adenine, cystine and glutamic acid respectively The fifth is not yet identified

(3) *E coli* strain *B* or *B/r* was grown in broth from an overnight culture to *c* 5 × 10^8 cells/ml and concentrated to 2 × 10^9/ml for treatment in *M*-9 buffer (It is necessary to use phosphate buffer since the reagent hydrolyses, albeit slowly, to give methane sulphonic acid, which is not adequately buffered by broth) Strain *B* was treated with a 0 1 *M* solution for times ranging from 8 min (100 per cent survival) to 15 min (20 per cent survival) and strain *B/r* with a 0 2 *M* solution for 10 min (70 per cent survival) Treated cells were diluted tenfold, washed, re-suspended in broth at *c* 10^8 viable cells/ml and aerated at 37° C Samples were withdrawn immediately and after various times of aeration for determination of total viable count and for assay of *T*6-resistant mutants (*B*/6) For the latter purpose, samples were mixed with phage *T*6, affording a multiplicity of between 10 and 50 for 5 min and then spread on plates each pre-spread with 10^9 phage particles, and incubated overnight at 37° C After each 2-hr aeration, the cultures were diluted 1 20 to preserve logarithmic growth The genuineness of the putative *B*/6 colonies was confirmed in a representative number of cases by replica-plating on to agar spread with 10^{10} *T*6 particles/plate The results are given in Table 2

The experiments with strain *B* were repeated a number of times, varying the conditions, including the subdivision of the control and treated cells into a number of parallel cultures, but in all cases the result was similar At 100 per cent survival the result was less dramatic but the yield of mutants always rose to between 5 and 20 times the control

Demerec[10] distrusted the procedure of growing the cells in fluid medium after treatment, on the ground that it did not permit discrimination between the progeny of early or pre-existent mutants and newly emerging mutants Our controls indicate that there is no difference between the time of generation of wild-type and mutant, nor selection effect of a sufficient order to invalidate the procedure adopted here

The main purpose of this article is to direct attention to the unusual properties of ethylating agents as mutagens Their apparent uniqueness could be attributed to their extremely low toxicity which permits the use of much higher doses (from the point of view of the amount of chemical reaction sustained) than is the case with other alkylating agents From this point of view the genetical observations present a problem to the chemist and biochemist Our

Table 2

Time (hr) of aeration in broth	No of divisions (approx)		Viable cells plated $\times 10^{-7}$		*B*/6		*B*/6 / 10^7 cells	
	Control	Treated	Control	Treated (19 per cent survival)	Control	Treated	Control	Treated
0	0	0	2 83	0 54	22	4	7 7	7 4
2	2 5	2	19 0	2 16	112	20	5 9	9 2
4	5 5	7	7 08	4 19	35	552	4 9	131
6	9	11	4 45	3 31	26	1,394	5 8	421
8	13	16	3 66	3 92	24	1,586	6 5	404
Time (hr)	No of divisions (approx)		Viable cells plated $\times 10^{-7}$		*B/r*/6		*B/r*/6 / 10^7 cells	
	Control	Treated	Control	Treated (67 per cent survival)	Control	Treated	Control	Treated
0	0	0	3 24	2 16	17	27	5 2	12 5
2	2	2	14 94	8 01	55	92	3 6	11 4
4	4 5	5	3 57	3 89	22	287	6 1	74
6	9	9 5	4 93	3 42	36	2,049	7 3	599
8	13 5	14	7 32	5 60	43	2,840	5 8	489

more exclusively chemically-minded colleagues have tended to regard alkylating agents in the capacity of anti-mitotic substances as mere destroyers of deoxyribonucleic acid and have, indeed, adduced much evidence of this potentiality. In their capacity as mutagens, however, assuming, as we know to be the case with phage, that this is mediated by reaction with deoxyribonucleic acid, extensive degradation of the genetic material can play no part unless one assumes that the ultimate mutagen is a breakdown product of deoxyribonucleic acid. This is unlikely since we know, for example, in the case of bromouracil[11] that incorporation of unnatural components into deoxyribonucleic acid is itself only a pre-mutational step. The possession of a mutagen which is active at high survival-levels provides an opportunity of identifying the reactions constituting the premutational step unobscured by lethal side-effects. In the case of bacteria we would like to establish whether in fact the ultimate mutation arises as a consequence of a primary reaction with deoxyribonucleic acid, leading perhaps to faulty replication at the actual site of reaction, and are considering the use of bacterial conjugation or transduction for this purpose.

From a different point of view, we feel that ethylating agents may raise chemical mutagenesis from the level of a laboratory trick to that of considerable practical importance, for example, in the field of plant breeding and industrial microbiology, and can fully agree with the words of Heslot *et al.*[3] " . . . nous considérons que ce corps peut avoir une utilisation pratique immédiate pour l'induction expérimentale de mutations chez les plantes cultivées". A method of preparation of ethyl methane sulphonate has been described by Ross[12].

In respect of one of us (A. L.), this investigation has been supported by grants to the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital) from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

Note added in proof. The sharp increase in toxicity of the ethyl methane sulphonate at concentrations nearing saturation reported above has now been shown to have been due to an impurity. We are unable to state the nature of this impurity, or whether it was present in the freshly prepared ester or developed on standing. It is certain, however, that the contaminant was neither an alkylating agent nor a mutagen in the systems studied. The yields of mutants given above are, therefore, valid but do not represent the maximum obtainable at the survivals indicated.

Using a more highly purified specimen it was possible to treat B/r with a 0.3 M solution for 30 min., namely 4.5 × the dose employed previously, while retaining virtually 100 per cent viability. The yield of $B/r/6$ colonies obtained after such a treatment rose to $10{,}740/10^7$ cells plated after 15 divisions of the treated cells; controls behaved as previously.

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[5] Kølmark, G., *C.R. Lab. Carlsberg, Sér. physiol.*, **26**, 205 (1956).

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[12] Ross, W. C. J., and (in part) Davis, W., *J. Chem. Soc.*, 2420 (1957).

FOSSIL POLLEN FROM SEYMOUR ISLAND, ANTARCTICA

By LUCY M. CRANWELL*

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DUSÉN[1], Gothan[2] and Halle[3], who worked on plant fossils collected by the Swedish Antarctic Expedition of 1901–3, make no mention of microfossils in the material. Halle[3] explained that the mode of deposition of the plant layers in the dark, slaty Jurassic beds of Hope Bay, near the northern tip of Graham Land, precluded study of the sporangia on the fronds of a species of *Todites*, for example. Dusén[1] and Gothan[2] do not seem to have looked beyond their poorly preserved leaf and wood fragments, respectively, when dealing with the younger deposits of Seymour Island and its environs. It is from this area that I have now found pollen grains and spores—the most durable and most conservative of plant organs, as well as the most eloquent indicators of past vegetation and possible climates.

The following notes on the microflora of a small rock sample from Seymour Island are thus, so far as I can discover, among the first published records of fossil microspores from the Antarctic. Sir Albert Seward provided the first with the type of *Pityosporites*; the second has just come to hand as a list in the September report of the Australian National Antarctic Research Expeditions. These important contributions are discussed more fully at the end of this article.

Bunt[4], in his preliminary report on Macquarie Island lignites, deplores the fact that so little use has been made of pollen in studying these southern deposits. I agree with Dr. Bunt, but I do not think, as he does, that the microfossil approach has been ignored; rather, I would suggest that some of the matrices have proved recalcitrant. Where I once failed to find recognizable remains in a Kerguelen sample, Cookson[5] isolated evidence of a flora particularly rich in conifers from 'coaly' and other materials from this subantarctic island. Again, although I have just had some success with Seymour Island material, I failed in 1939 to recover either pollen grains or spores from the same rock sample

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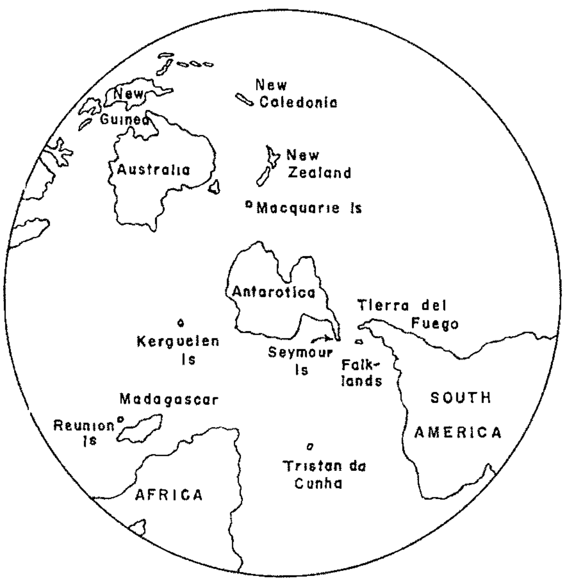

Fig 1 Map showing position of Seymour Island in relation to Palmer Peninsula, formerly known as Graham Land

In view of the considerable age of the parent deposits, on which Dusén[1] and Halle[3] did not agree, and because of the dearth of information about antarctic and subantarctic plant fossils in general, it seems worth while to present a brief account of the most striking components so far noted A fuller report will follow after further study and an exchange of opinions with others interested in plant distribution in these regions

On Seymour Island (Fig 1) sandstones lie at the surface, or are partly covered by huge angular blocks of basalt, whereas on nearby Ross Island and on the mainland they are hidden by the volcanics Dusén[1] writes of coarse-grained tuff and calcareous sandstone, of some fine-grained material, and of the extreme rarity of richly calcareous material In deciding that these fossiliferous layers are not of early Tertiary age he seems to have been most influenced by the likeness of his fossil leaves to their living counterparts, as also to magellanic fossils he had already dated as Upper Oligocene or Lower Miocene In addition he believed strongly that a subtropical element occurred in the lowlands of Antarctica and that this antedated the spread of the Fagaceae northwards to form the so-called Fagus Stage in South America For fifty years the Seymour Islands beds have thus been referred to as Eocene or Oligocene Harrington[6] does not mention the area in his summary of recommended names for antarctic rock units, as his committee dealt only with East Antarctica, but he has informed me, after reading part of my manuscript, that recent work by British geologists with the Falklands Islands Dependencies Survey has shown conclusively that there is an angular unconformity on Seymour Island the beds in the south-west are Cretaceous (Lower to Middle Campanian) while those in the north-east are probably Lower Miocene This clears up the long-standing confusion and makes it clear that no early Tertiary deposits have been discovered

My sample was collected by the Swedish Expedition and it is numbered 260/39 in the collections of Auckland Museum Before sampling it looked most unpromising, being a very small, pale grey, fine-grained and weakly laminated fragment, quite unlike most of the material handled by Dusén Only the faintest flecks of carbonized remains showed before the lamina were separated to reveal a few larger but excessively macerated leaf traces As the matrix called for further examination, I submitted it to Prof John W Anthony, University of Arizona Geology Department, who describes it as "essentially a tufaceous limestone" (personal communication) A thin section showed the following minerals after leaching calcite, quartz, plagioclase and orthoclase feldspars, and amphibole (probably hornblende), and a fairly large percentage of curved glass shards Of this association of minerals Prof Anthony adds "Apparently this glass was ejected from a volcanic vent at the time the limestone was forming and it settled through water to become incorporated into the unconsolidated limestone The other mineral fragments, together with a few of what appear to be igneous rock fragments, settled in the same way" An extremely small faunal component was noted in this section

The attrital component, treated with a modified Schulze's solution, comprises pollen grains, pteridophyte spores, fungal teleutospores, mere traces of algae and fragments of cuticle Preservation is sometimes excellent, but most of the pollen grains are broken or eroded, and wood and cuticles are macerated almost beyond recognition, although occasional hairs persist Some of the larger and seemingly more fragile grains, 50μ and more in diameter, are also the best preserved This contrast suggests a history of abrasive water-carriage, on one hand, and gentler sifting down through the air of wind-blown types to the rendezvous in coastal sediments

As these notes will show, there is sufficient mixture of familiar floristic types to suggest derivation from varied communities, probably mainly from forest at different elevations The high percentage of unfamiliar pollen grains in particular suggests that some types may have been washed in from older deposits

The dominants, as indicated by the pollen, are conifers and southern beeches (species of *Nothofagus*) a similar assemblage occurs to-day all around the southern hemisphere (with the exception of the African–Madagascar region) and in montane New Guinea and New Caledonia, as Dr van Steenis's reports[7] on the results of the Archbold Expedition recently showed In New Zealand it has been traced as far back as the Cretaceous[8–10]

GYMNOSPERMS mainly podocarps and araucarians *Araucaria* grains are mainly smaller than those described by Cookson[5] from Kerguelen deposits *Agathis* and other furrowless coniferous types appear to be present, in a crumpled condition Bisaccate and trisaccate grains are fairly common, ranging through the *Podocarpus – Acmopyle – Dacrydium – Phyllocladus* complex[8,11], together with allied but distinctive forms foreign to those of the living species The phyllocladoid component is varied, the grains often being less than half the size of known living and fossil types[5,8,10] In Fig 2(4) is shown a *Phyllocladus*-like grain (to be described elsewhere) about 17μ in length, which has the 'spunky' bladders reminiscent of some living dacrydia No tuberculate grains were seen Most larger grains tie in with *Podocarpus*, *Acmopyle* and the *Dacrydia* seemingly most nearly allied to *Podocarpus*[8] [Fig 2(2,3)] the smaller grains seem to suggest some meeting ground between *Phyllocladus* and the second pollen group in *Dacrydium* (typified by *D cupressinum*, *D bidwillii*, etc), both of which have radially strengthened bladders Where grains are small, smooth, furrowed

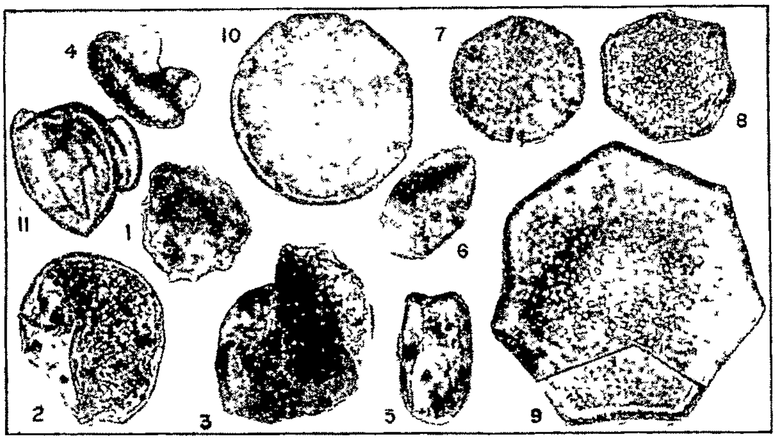

Fig 2 Microspores fossil from Seymour Island (1–7), living types (8–11) (*A*) *Cyathea*-like fern spore, 25μ (1) (*B*) Pollen grains (*a*) coniferous of *Podocarpus*-type (folded, showing one bladder, 2, 3), *Phyllocladus*, 17μ, focused on lower bladder (4), *P alpinus*, 28μ New Zealand, (11), (*b*) palmoid, 25μ (5), (*c*) dicotylous (6–10), *Nothofagus* pollen grains of *fusca* group, 24μ, folded in half (6), living *fusca*, 37μ, New Zealand, *N whenua* n sp, 18 5μ (7), *N bernhardi*, 23μ of *brassi* group, New Guinea (8), of *N menziesii*, 55μ, New Zealand (9), with inset showing fissurable points on equator (× 660–840)

and variously folded along the furrows, it is impossible at this stage to tell whether they belong to gymnospermous or palmoid types [cf Fig 2(5)]

ANGIOSPERMS All the fagaceous pollen recognized falls into the first two of the three known *Nothofagus* pollen groups, as exemplified by the following living species[10,12,14] (1) *fusca*, grain rounded in outline, exine firm, scabrate, pore rims strongly thickened, pore membranes sunken, (2) *brassi*, seemingly an intermediate type grains usually strongly angled, often embayed between angles, rim-thickening and pore membranes reduced or lost, and (3) *menziesii*, which has larger, thinner-walled, sharply scabrate (spinulose) grains, and only vestiges of pores, their function being taken over by wide furrow-like areas (as in most species of *Quercus*) which rupture characteristically under pressure All members of these pollen groups are anemophilous forest-formers to-day, and some form low scrub under adverse conditions The *fusca* group is important in southern South America, Tasmania and New Zealand, in New Zealand, at least, hybridism between its members is rife[15] Pollen of the *brassi* type was first isolated from Miocene deposits in New Zealand[12] living species in New Guinea and New Caledonia are now known to produce pollen of this type exclusively[14]

The *menziesii* group is found to-day in cool forests of South America, and in Australia, Tasmania and New Zealand Its fragile pollen grains occur in low frequencies in peats, etc I have not found any in the Seymour Island material, although Dusén[1] compared fossil leaves with those of *N obliqua*, a South American member of this group It is to be expected that some trace of its pollen will be found somewhere between these western and eastern limits, possibly in even older deposits than those of Seymour Island In New Zealand, Couper[10] has recorded pollen closely allied to that of *N menziesii* as far back as the Upper Cretaceous, and he considers that his *cranwellae* type (*brassi* group of Cookson and Pike[14]) goes back to the Lower Cretaceous This type has its oldest Australian record in the Tertiary

All the antarctic beech pollen is small, ranging from about 14μ to 24μ This puts it at the lowest range of *brassi*-group pollen[14] Some grains approach the *brassi* type, but all that I have seen lack embayment of the intercolpar areas

One very small and distinctive type, which I am naming *N whenua*[15], may be compared with *N bernhardi* of New Guinea, as figured by Cookson and Pike[14] However, it has features that lead me to surmise that the *menziesii* group, despite its large size, could be a lineal descendant of this or an earlier small, sturdy, star-like grain

Both the gymnosperms and the angiosperms of Seymour Island, therefore, suggest antiquity through their pollen record

Various families are represented in lower frequencies, for example, Cruciferae, Myrtaceae, Proteaceae (aff *Lomatia*, as figured by Auer *et al*[16]), Loranthaceae (aff *Loranthus micranthus*), Oenotheraceae (badly eroded *Fuchsia*-like grains, comparable with those of *F magellanica*), and perhaps Winteraceae of unrecorded type Various very small grains (9–20μ) are fairly common, they may belong to the Cunoniaceae (cf *Weinmannia*) or the Elaeocarpaceae Even with sub-fossil material of this nondescript type identifications are not easy

PTERIDOPHYTES Spores occur sparingly and are usually well preserved The Cyatheaceae is represented by weakly trilete verrucose spores, and the Schizaeaceae by a very rare and small spore with striations reminiscent of the massive *Schizaea laevigata* spore described by Selling[17] from New Caledonia Halle[3] reported both families from his Jurassic material

The perfect condition of some of the very small pollen grains is of interest it may be that abrasion is most severe when grains are greater than 10–15μ in size

No spores of lycopods or pollen grains of Compositae, Centrolepidaceae, Restionaceae Pandanaceae, Gramineae or Cyperaceae have been recognized These absences seem significant Among the unidentified types were tetrads and spiny grains, a few heavily reticulate grains, and a palmoid group already mentioned It should be noted that the total number of microspores or fragments, per slide, is exceedingly low

DATING Redeposition of microspores from older beds has been noted as a possibility This older component may well be Cretaceous a Senonian (for example, Campanian) date does not seem excessive to me For the younger component an upper Tertiary limit cannot as yet be hazarded it contains types represented in early Tertiary deposits elsewhere in the southern hemisphere and seems to lack others, such as grasses, sedges and composites, which are usually present by the Miocene

These records enrich the antarctic lists derived from megafossils They give no evidence of the presence of *Fagus* (as reported by Dusén[1]) but emphasize instead the importance of *Nothofagus* in the antarctic background As pollen evidence accumulates in the southern hemisphere so shrinks the *Fagus* empire postulated in the writings of von Ettingshausen, and is replaced by a condominium of southern beeches and conifers, which are still, in very similar form, compatible in cool areas to-day

PITYOSPORITES ANTARCTICUS I referred earlier to Seward's controversial note of 1914[18], in which he described a small plant body as a two-winged pollen-grain This object was lodged in a partially decayed stem of *Rhexoxylon priestleyi* found by Sir Raymond Priestley in a boulder of Beacon Sandstone on the medial moraine of the Priestley Glacier, behind Terra Nova Bay, in Victoria Land

Seward's interpretation of this inclusion met with such opposition, except, perhaps, from Dr H Hamshaw Thomas and Dr and Mrs Harry Godwin, that by 1933 [19] he was writing wistfully of "my unfortunate pollen grain", and pleading for his "fancy" that "Fancy with fact is just one fact the more" The opposing camp held to its view that he was probably dealing with a crushed pith cell

Seward had instituted the genus *Pityosporites* to receive the new material (of which two examples were found), thinking that it could include other pollen grains of similar size belonging to "*Pinus* and other Abietineae" He soon decided, however, that he had over-stressed likeness to this northern group · on geographical grounds such pollen grains were more likely to have been produced by some member of the predominantly southern Podocarpaceae Florin[20] accepted this reasoning as he writes of the grains as "possibly podocarpaceous" in his valuable paper on conifers of Chile and other southern lands Seward, however, had pointed out that other groups known to have occurred in Antarctica could have produced these two-winged grains The question of their identity, as of the age of the boulder, was thus left open

If we grant, as I am happy to do, that Seward really discovered pollen grains, it is interesting to dwell further on the characteristics supplied by, or suggested by, his description and illustrations In size (80μ) the objects are comparable with pollen grains of some living species of *Pinus* and *Podocarpus,* but come closer to the latter in the outline of the thick-walled cap, the strongly rhomboidal body, and the rather large distinctively reticulate wings, which show up best in the 1914 photomicrograph If the sandstone in which the stem was embedded proves to be beyond the time-range of known members of the Podocarpaceae, other possibilities must be considered, and Seward has already mentioned *Glossopteris* and the Caytoniales Concerning the former, Balme and Hennelly[21] hold that there is still inadequate proof of the discovery of microspores Those of the Caytoniales differ from the antarctic type in their strikingly smaller size (less than 36μ, as a rule, including the wings), rounder, smaller bodies, narrower furrows, and a tendency, at least in some shown me by Dr Jane Gray, to develop radial ("dacrydioid") wing thickenings In addition, the body is little overlapped, if at all, by the wings On the other hand, the antarctic grain is matched for size by microspores of *Pteruchus,* produced by pteridosperms (seed-ferns) and first described by Thomas[22] (see also Couper[23] Pl 26, Fig 9) from possible Middle Triassic beds in Natal, and, among other localities, from Australia as well in the southern hemisphere by Balme and Hennelly[21] In some examples the body is seen to be partly hidden by the wings Illustrations have been presented in distal view, the wings appearing flat this appearance is also characteristic of certain living species of *Dacrydium* and *Podocarpus,* the apparently flaccid wings of which are nevertheless seen to be more or less turgid if a lateral view can be obtained Thus, after acknowledging very strong similarities to podocarpaceous grains, we come full cycle to consider whether the bodies in the pteridosperm stem (*Rhexoxylon*) may not have been pteridosperm pollen grains

PERMIAN RECORDS Thanks to the co-operation of Dr H J Harrington (personal communication October 19) I am able to summarize the results of very recent microspore studies of carbonaceous shale and coal from the Amery Formation, which Crohn[24] states is "regarded as the equivalent of the lithologically and structurally similar beds of the Beacon Formation" Dr Crohn reports thirteen types and is able to assign a Permian age to these deposits · his identifications were supplied by Permian specialists at the Coal Research Section, Commonwealth Scientific and Industrial Research Organization, Sydney Trilete spores amounted to 9 per cent, while 11 per cent were monocolpate and unwinged, and 80 per cent bisaccate, or with an encircling wing, as in the two forms of *Florinites* Bisaccate types included high frequencies of *Lueckisporites* (distinguished by striations on the proximal (cap) side of the grain) but only 2 per cent of *Pityosporites* sp Fuller reports will be awaited with great interest Strong Australian and Indian affinities can be assumed from comparison with other work on Gondwanaland forms by Dr C Virkki in India, and by Balme and Hennelly in the Australian region

I wish to thank Prof Terah L Smiley and Dr Jane Gray of the Geochronology Laboratories, Prof John W Anthony of the Geology Department, and Mr Dick Shutler, jun , all of the University of Arizona, for help of various kinds Mr Shutler gave me much laboratory assistance, including the running of this sample, during the past year I have received pollen samples from Dr George Taylor and Dr R A Howard, directors of the Royal Botanic Gardens, Kew, and of the Arnold Arboretum, respectively, and I am indebted to Dr Gilbert Archey, director of the Auckland Institute and Museum, for unfailing support of my work

In addition I wish to thank Dr Harrington of the Geology Department, University of New England. N S W , for his summaries of recently published British and Australian work, to which I could not otherwise have paid tribute in this article

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FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, December 29

Radar and Electronics Association (at the Royal Society of Arts, John Adam Street, Adelphi, London, W C 2), at 7 30 p m —Dr K R Sturley "High Quality Sound Broadcasting" *

Wednesday, December 30

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 2 30 p m —Dr J D Carthy "Animal Senses and Reactions" (First of two Juvenile Lectures Further lecture on January 6)

Institution of Electrical Engineers (at Savoy Place, London, W C 2), at 3 p m —Mr G G Gouriet "Colour Television" (Christmas Holiday Lecture To be repeated on Thursday, December 31)

Friday, January 1

Plastics Institute (in the Lecture Theatre of the Institution of Electrical Engineers, Savoy Place, London, W C 2), at 2 30 p m —Dr N A de Bruyne "Sticky Plastics" (Sixth Lecture for Young People)

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturer in the Department of Veterinary Pathology—The Secretary, The University, Edinburgh (December 31)

Lecturer (preferably an experimental physicist with an interest in low temperature physics, electron resonance, or some other branch of solid state physics) in Physics—The Registrar, Queen Mary College (University of London), Mile End Road, London, E 1 (December 31)

Scientific Officer (with a first- or second-class honours degree in civil engineering or physics, or equivalent qualifications) at the Hydraulics Research Station, D S I R , Howberry Park, Wallingford, Berks, for studies of hydraulic problems in the field of civil engineering, including scale model investigations—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting E 489/9A (December 31)

Senior Scientific Officers/Scientific Officers (suitably qualified in physics, engineering and mathematics) in the Aerodynamics Division of the National Physical Laboratory, Teddington, Middlesex, for a programme of fundamental research on problems of flight at high speeds—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 535/9A (January 1)

Senior Lecturer in Clinical Biochemistry at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (January 4)

Advisory Officer (with a degree in agriculture or in pure science, a sound knowledge of poultry husbandry with experience of experimental work and advisory work among poultry farmers) in Poultry Husbandry—The Secretary, The North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (January 9)

Physical Chemist (with a good honours degree and suitable research experience, preferably industrial, but not necessarily in the sugar industry) in the Department of Sugar Technology, Imperial College of Tropical Agriculture, Trinidad, West Indies—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W C 2 (January 18)

Chief (with high academic qualifications and research experience) of the Division of Entomology, Commonwealth Scientific and Industrial Research Organization, Canberra, A C T , Australia—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting Appointment No 180/157 (January 23)

Babcock and Wilcox Fellow in Nuclear Engineering—The Registrar, Queen Mary College (University of London), Mile End Road, London, E 1 (January 30)

Lecturer in Anatomy in St Salvator's College, St Andrews—Joint Clerk to the University Court, College Gate, St Andrews (January 31)

Librarian at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (January 31)

Senior Lecturer/Lecturer in Chemical and Extraction Metallurgy at the University of New South Wales, Australia—The Agent General for New South Wales, 56–57 Strand, London, W C 2 (Australia, January 31)

Albright and Wilson Research Fellows in Chemistry (one at Pembroke College and one at Worcester College)—Dr C J Danby, Worcester College, Oxford (February 1)

Chair of Morbid Anatomy in the London Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W C 1 (February 1)

Chair of Physiology in the London Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W C 1 (February 1)

Lecturer in Veterinary Anatomy at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, February 27)

Assistant Lecturer or Lecturer in the Zoology Department—The Secretary and Registrar, The University, Southampton

Cell Biologist (with a degree and research experience (preferably a Ph D.) in biology, microbiology or biochemistry), to take part in a research project on the fundamental biology of fibroblasts—Dr J M Mitchison, Department of Zoology, The University, West Mains Road, Edinburgh 9

Chair of Meteorology—The Secretary, McGill University, Montreal, Canada

Programmer (with good mathematical qualifications, and preferably either statistical or programming experience), to work on statistical problems arising from agricultural research and surveys—The Secretary, Rothamsted Experimental Station, Harpenden, Herts

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Water Research Association Fourth Annual Report, 1958–59 Pp 31+4 plates (Redhill Water Research Association, 1959) [2210

Cement and Concrete Association The Analysis of Right Bridge Decks Subjected to Abnormal Loading By Dr P B Morice and G Little Pp 43 (London Cement and Concrete Association, 1959) [2210

Department of Scientific and Industrial Research Report of the National Chemical Laboratory, 1958 Pp iv+97 (London H M Stationery Office, 1959) 5*s* 6*d* net [2210

Department of Scientific and Industrial Research Forest Products Research Record No 30 The Natural Durability of Timber By D N Smith (Wood Preservation Series, No 4 Second edition) Pp ii+26 (London H M Stationery Office, 1959) 2*s* net [2210

Forestry Commission Board Mill Survey, United Kingdom—Economic Study By Sandwell and Co Ltd , Consulting Engineers, Vancouver, Canada Pp vi+70 (London H M Stationery Office, 1959) 5*s* net [2210

Royal Greenwich Observatory Bulletins No 15 Time Service 1959, January–March Pp 223–240 (London H M Stationery Office, 1959) 3*s* 6*d* net [2210

Philosophical Transactions of the Royal Society of London Series A Mathematical and Physical Sciences No 1003, Vol 252 (15 October 1959) Solution of a Diffraction Problem 1 The Wide Double Wedge 2 The Narrow Double Wedge By H M Nussenzveig Pp 1–51 16*s* No 1004, Vol 252 (15 October 1959) Reflexion Levels and Coupling Regions in a Horizontally Stratified Ionosphere By M L V Pitteway Pp 53–68 5*s* (London Royal Society, 1959) [2210

Other Countries

United States Department of the Interior Fish and Wildlife Service Fishery Bulletin 154 Life History of the Sea Lamprey of Cayuga Lake, New York By Roland L Wigley Pp iv+561–617 (Washington, D C Government Printing Office, 1959) 40 cents [2210

United States Department of Agriculture Agricultural Research Service Technical Bulletin No 1202 Mormon Crickets in North America By Claude Wakeland Pp ii+77 (Washington, D C Government Printing Office, 1959) 50 cents [2210

Centro Brasileiro de Pesquisas Fisicas Notas de Fisica Vol 5, No 8 The Imaginary Part of the Optical Potential By L C Gomes Pp 75–85 Vol 5, No 9) An Analysis of the Solar Daily Variations of the Primary Cosmic Radiation Measured with the IGY Neutron Monitor Network By Lêda A de Moura, Georges Schwachheim and Erich R Willner Pp 87–101 (Rio de Janeiro Centro Brasileiro de Pesquisas Fisicas, 1959) [2210

Report of Her Majesty's Astronomer at the Cape of Good Hope to the Secretary of the Admiralty for the year 1958 Pp 12 (Cape of Good Hope Royal Observatory, 1959) [2210

Bulletin of the Astronomical Institutes of the Netherlands Vol 14, No 490 (1959 September 22) Quantitative Photometric Measurements with a Lyot Filter By Miss I G van Griethuysen and J Houtgast Pp 279–298 Vol 14, No 491 (1959 September 24) Structure and Dynamics of Messier 3 By J H Oort and G van Herk Pp 299–321 Vol 14, No 492 (1959 September 26) Neutral Hydrogen in M33 and M101 By Louise Volders Pp 323–337 Annalen van de Sterrewacht te Leiden Deel 21, Vierde Stuk Observations of Variable Stars in the Globular Clusters NGC 4590 (M68) and NGC 6266 (M62) By S L Th J Van Agt and P Th Oosterhoff Pp 253–290+4 plates (Leiden and Utrecht Astronomical Institutes of the Netherlands, 1959) [2210

United States Department of Agriculture Agricultural Research Service Agricultural Handbook No 152 Mosquitoes of Medical Importance By Richard H Foote and David R Cook Pp ii+158 (Washington, D C Government Printing Office, 1959) 2 50 dollars [2210

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APPLICATION OF SCIENCE IN INDUSTRY

WITH their third report, written for the Science and Industry Committee set up by the British Association in 1952 and re-constituted in 1954 with the additional sponsorship of the Royal Society of Arts and the Nuffield Foundation, Prof C F Carter and B R Williams complete the greater part of their work on the terms of reference of that Committee*. Their analysis of, and broad conclusions on, the factors governing the speed of application of science were reported in their first book, "Industry and Technical Progress", in 1957 In a second volume, in 1958, "Investment in Innovation", some of the earlier material was re-examined to elucidate factors which influence industrial investment in new plant and equipment Some of that material is again discussed in this concluding volume, which is concerned to outline a policy for action

The proposals set forth are grouped broadly according to whether the action required is by industry or by Government, and at the present moment, in view of the recent establishment of a Minister for Science, the second part of the book, in which various important aspects of public policy are examined, is of special interest The reader is left in no doubt that some conditions of technical progress are created by Government action, though he may be surprised at the limitations of existing knowledge as to the extent and effect of such action There is still, in fact, a very considerable field calling for further inquiry, especially perhaps on the financial side, as was particularly emphasized in "Investment in Innovation" On numerous points the facts on which public policy should be based have still to be determined, and while, like its predecessors, this third volume should stimulate as well as guide thought, there is nothing in it to urge hasty decision or action upon Lord Hailsham as Minister for Science

Profs Carter and Williams begin their consideration of the instruments of policy by which the Government can support and assist technical progress with a broad discussion of the strategy of Government aid—a discussion which is surely as broad as Lord Hailsham himself or Sir Hugh Beaver has already given, although it touches on some matters of Government policy directed at other objectives which may incidentally affect the advancement of technique This Government help may be provided by many different departments and State-sponsored bodies, for example, the National Research Development Corporation In some Departments, however, affairs may be involved in such instruments as purchase tax, which may incidentally hinder the adoption of new techniques Without entering on any analysis of the actual organization for Government assistance to research and development even, to the extent to be found in the survey made by a study group of the Royal Institute of Public Administration and published in 1957 in "The Organization of British Government", Profs Carter and Williams suggest that some re-assessment is needed of Government aid to research and development, designed to make it more likely that it will give help to industry at the points where, in the long run, help is most needed

This re-assessment would require separate consideration of the needs for advice, for assistance to research and for assistance to development, and at present Profs Carter and Williams doubt if it can be said that a Government policy on the application of science really exists The facts on which such a policy should be based, they assert, have never been collected or assessed Substantial research is needed, and the problem is both technical and economic, requiring extensive and continued study by a group containing both scientists and economists They do not think that such a group exists at present, but without it policy-making tends to go no further than a statement of generalities

It appears to be to the Advisory Council on Scientific Policy that the Science and Industry Committee looks for progress here, although it is implicit in what is written in the present report that the Advisory Council has been, particularly of recent years, too preoccupied with comparatively minor matters It is believed that Lord Hailsham intends to make increasing use of the Advisory Council, and he may well look to the Council for help in seeking answers to some of the more fundamental questions, such as the proper place and the right limit for Government action in speeding the application of science, the scale of Government effort, the extent to which it should be concentrated or widely diffused and, if concentrated, the points of maximum effort, to which answers must be sought and found before a national policy is formulated

Besides this emphasis on the need for much more patient fact-finding, stress is laid on the importance of 'cost- and profit-mindedness' in planning national research policy, as in planning research in an individual firm, and this aspect must be given due weight in making the inevitable choice between fields of effort It is duly noted that the Council for Scientific and Industrial Research appears to have this question of priorities very much in mind, but it is also clear that the Science and Industry Committee is somewhat reserved as to whether sound decisions can yet be made The report, in fact, goes no further than to suggest a few principles

The Committee hesitated, for example, to recommend more than occasional use of the policy of 'reinforcing success', helping industries which are already showing signs of lively innovation to advance still faster, although the principle deserves examination On the other hand, these studies support the policy of concentration at weak points, not indeed to the extent of helping weakness wherever it is found, but rather of helping industries unlikely to achieve rapid technical progress with their own resources, and especially those industries which have great promise of change or development There is no support for the practice, too common already in British industry, of bolstering the inefficient

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* "Science in Industry Policy for Progress" By C F Carter and B R Williams Pp ix+186. (London Oxford University Press, 1959) 21s. net

Such a policy is not easy to apply, but obviously it is one which must be carefully considered in determining State policy towards the research associations in Britain Here the further suggestion is made that assistance for advisory services, including educational services, should be provided separately from that for research and specifically earmarked Such a step would have certain advantages in assessing the magnitude of the national effort in research, and the recognition of the educational work of the research associations is in keeping with the view that the Government's fundamental contribution to technical progress is in its support of training facilities Beyond that the question of balance between research and development is all-important

In this matter of development, some extension of the practice of establishing development companies by the research associations is recommended, as well as extension of sponsored research facilities The studies made for the Science and Industry Committee suggest, however, that existing facilities for the finance of development through the National Research Development Corporation are not fully used, and that Government support may need to go beyond the financing of development contracts While Government Departments as well as research associations should make full use of the experience and funds of that Corporation, it may occasionally be desirable to create State development companies to manage development in a defined field Nevertheless, every effort should be used to make the National Research Development Corporation an effective instrument of development on behalf of all Government-aided research bodies which cannot achieve adequate development from their own resources, and its powers to stimulate research (as well as development) should be used with vigour to fill in gaps which may appear in the structure of industrial research, or to recommend action for filling them to the national research councils

On this view there is a strong case for placing the National Research Development Corporation within the authority of the Minister for Science, and probably within the responsibility of the Advisory Council on Scientific Policy Its responsibility to the Board of Trade is obviously anomalous, and although Profs Carter and Williams do not commit themselves as to whether they regard the Corporation as sufficiently in direct touch with the economic as well as the technical problems of industry, they are in no doubt as to the value of its present work No evidence is presented as to the advantage which any new type of body would offer in assessing Government aid to industry as a problem in the joint use of economics and technology

On educational policy the report makes numerous sound and sensible comments, few of which are new, but some of which are still badly needing attention Such, for example, are the reminder of the waste of highly trained man-power which follows from an insufficient supply of technicians, and the clear warning that, unless corrective measures are taken immediately, a swift rise in the numbers of scientists and technologists available in the mid-1960's will be unmatched by an equivalent rise in the number of technicians and craftsmen, and the existing lack of balance will be made worse Again, while no evidence was found that industry in general is failing to get its fair share of first-rate men, the inquiry pointed to the desirability of further study of the cost of additional years of education in relation to the benefits to be expected. Here the evidence indicates that a higher scientific content in the education of most citizens would promote technical progress, partly by removing the obstacle which 'scientific illiteracy' offers to the communication of ideas, and partly because a greater reserve of people with some grounding in science would assist industry to meet demands, perhaps unexpected, for new types of technical skill

There are also sound comments on the importance of increased training for craftsmen and apprentices, increased attention to the education of technicians, and, by the universities, to the finding of the best form of education for managers , and the bearing of a better provision for laboratory technicians in schools on the supply of science teachers is duly noted Some of the points made in regard to the supply of science teachers have already been considered by the Advisory Council on Scientific Policy, but they are presented here in a way which shows very clearly their direct bearing on the responsibilities now entrusted to Lord Hailsham The educational implications of his task could not easily be summarized better, and he can scarcely overlook the emphatic suggestion that effective research in the use made of scientists and technologists would make the planning of educational facilities much more reliable

On taxation policy the report does not add substantially to the conclusions outlined in "Industry and Technical Progress" , and it gives little support to the view that high taxation discourages technical advance, although it concedes that it could do so It urges that it is difficult to devise reductions in taxation which will stimulate technical progress without also giving large benefits to firms in which progress is unaffected by taxation, or to firms which would be unprogressive whatever the level of taxation A lowering and equalization of taxes on expenditure, and a reduction in surtax rates would, however, probably favour technical progress, and when increases of taxes are necessary, widely spread increases are least likely to affect technical progress What matters most, however, is that changes in taxation should be as infrequent as possible, the Committee's studies confirm the conclusion that the uncertainty created by such changes and the expectation of tax changes have an unsettling effect on planning technical advance, and while the report recommends specifically the consideration of special investment allowances for development costs and also of a scheme by which firms would be allowed to write off their assets for tax purposes at any rate they chose, subject to adoption of the same rate in their accounts, these suggestions are subject to that over-riding consideration

Here again the importance of Lord Hailsham's recent appointment is evident If this consideration is to be given due weight at Cabinet level, it is important that the implications should be put to the Cabinet by a Minister whose responsibilities for scientific and technical progress are as unequivocal as are those of the Chancellor of the Exchequer in the financial field Moreover, there are other proposals advanced regarding the effect of taxation on technical progress which have far-reaching political implications, and can accordingly only be considered at a level where those political considerations can also be given due weight Likewise, the report rejects the idea that there is any general principle that protection favours (or retards) technical progress, and doubts are expressed as to the wisdom of abolishing independent review by the Import Duties Advisory Committee in applying the Import Duties Act, and as to whether issues of technical progress will be of regular substantial importance in arguing cases before the Restrictive Practices Court No changes are recommended in the legislation against restrictive trading agreements and monopolies, but strong support is lent to all that has been urged elsewhere as to the importance of management giving more attention to overcoming the fear of redundancy This is the most hopeful means of meeting the restrictive practices of labour, which do occasional damage to technical progress

So far as can be judged, therefore, the recommendations of the report are in line with the current trend of opinion in Britain and with much evidence that Lord Hailsham has now before him He has already, for example, declared his intention of strengthening the voice of the Advisory Council on Scientific Policy, though what is most wanted here is the authority which would ensure that due heed is paid to the findings and recommendations of that Council The stress once again laid on the importance of provision for research and technical education should also encourage proposals already in train, and, no less important, direct fresh attention to the question of balance and phasing. Lastly, the emphatic opinion expressed as to the serious handicap which insecurity of capital programmes can impose on technical progress is valid far more widely than in the nationalized industries, on which it is primarily based, and with a Minister for Science there is perhaps a better prospect of representations being made at a high enough level and an early enough stage to check excessive change.

THE HISTORY OF WESTERN THOUGHT

Wisdom of the West

By Bertrand Russell Edited by Paul Foulkes Pp 320 (London Macdonald and Co (Publishers), Ltd , 1959) 63*s* net

THIS is Lord Russell's second brilliant venture into a comprehensive history of Western (mainly philosophical) thought Again there is the freshness of style, the attempt to relate scientific, logical and sociological issues, though it should be said that, as in the earlier work, the selection of material on the whole is conventional Little attempt has been made, for example, to include more recent research into the medieval foundations of scientific thought, or again, if the relations of science and seventeenth-century philosophy are touched upon, the philosophical contributions of later centuries are given rather more in isolation from contemporary scientific currents None the less, the range is encyclopædic, stretching from the glory of Athens (which comprises almost one half the book) to Frege, Bergson, Freud, Wittgenstein, Jaspers and Sartre

The most fascinating aspect of the new book, however, is its illustrations historical sites and the great thinkers of the past mingle with reproductions of historical scientific apparatus, and these again with diagrams meant to illustrate the trend of an abstract argument, the whole capped by a number of compositions by John Piper an exciting excursion into the field of 'visual aids' No brief review could do justice to the mere pleasure with which the interested reader will turn over the pages, to be dazzled by the variety of the contents

Of course, despite the brilliance and apparent novelty of presentation, it should be realized that on the whole this is old wine poured into new bottles To be sure, many of the harsher value judgments of Russell's past writings have been toned down, and there is a generous inclusion of views with which Russell may not always have sympathized, like those of Vico, Bergson, Kierkegaard and many others But there are still the rough and ready divisions into the Continental rationalists (who are rather wicked) and the more virtuous British empiricists, supported arbitrarily by the quite unproved suggestion that the diagrams representing these two types of philosophical systems are, respectively, a pyramid standing on its head. as against the other, standing on its feet (p 219) If anything is true, it is that *any* theory of knowledge which claims to be based on a specific limited 'basis' on which all the rest is said to depend (whatever the nature of the basis) should be represented by a pyramid standing on its head . which is an example of the general criticism that the apparent plausibility of a diagram representing an abstract argument could be a dangerous tool in the hands of an unscrupulous teacher Bacon, as usual, is charged with completely ignoring deductive procedures, the use of hypothesis, and the notion of an underlying 'invisible' structure of matter, though so far as the evidence goes it is more likely that this was a matter of emphasis rather than omission Peirce (late nineteenth century) is credited with the foundation of the hypothetico-deductive method, a statement which only emphasizes the (usual) omission of earlier writers such as Whewell and Jevons, not to mention three centuries of medieval contributions to the subject Kant's thing-in-itself is made a condition of inter-subjective experience (p 241), which is (to say the least) a misleading appraisal , Mill's immensely subtle argument about the foundations of inductive reasoning is dismissed with the usual hackneyed remark that it is 'circular' These examples (though they could be argued) suggest that despite the undoubted sharpness and accuracy of most of the accounts to be found here, the author's authority is no substitute for caution on the part of the reader, particularly when it is remembered that the best of the histories of philosophy are those that are deeply felt and take up a certain position This becomes obvious when the discussion centres around the more recent of Russell's philosophical interests, such as pragmaticist theories of truth, when the argument, though still as lucid as ever, becomes rather more heated

But these are minor criticisms Certainly this new excursion into our cultural heritage is another astonishing venture testifying to the brilliance and almost legendary energy of its author

GERD BUCHDAHL

A HISTORY OF IRON AND STEEL IN CHINA

The Development of Iron and Steel Technology in China

By Dr Joseph Needham (Second Biennial Dickinson Memorial Lecture to the Newcomen Society, 1956) Pp xii+76+31 plates (London The Newcomen Society for the Study of the History of Engineering and Technology, 1958) 57*s* , 8 15 dollars

THIS book, an expansion of a lecture founded in memory of Dr H W Dickinson, who was educated at the Manchester Grammar School and at Owens College, is beyond doubt a first-rate contribution to scholarship. In the field of Chinese science and technology the author speaks with a unique authority based on both wide and deep knowledge

That China had an ancient and, for the times, an advanced metallurgical industry has long been known, but isolated as it was, the exact nature and chronology of this have been largely matters of conjecture So far as iron and steel are concerned, we now know how and when it developed, and a most astonishing story it is Although in Europe it was the end of the fifteenth century A D before molten cast iron was first produced except by accident, Dr Needham adduces the most cogent evidence to show that this was being done in China on a by no means insignificant scale two thousand years before How this was done, the product obtained, and the probable reasons —the existence of ores high in phosphorus producing highly phosphoric irons of increased fusibility and the invention of really effective double-acting bellows —are all referred back to the literary sources and illustrated The fifty-odd illustrations, ranging from cast iron moulds of the fourth century B C to photomicrographs illustrating modern investigations of the processes described, are all of great interest and value

From the second century B C , if not before, this cast iron was used to produce steel by a most carefully controlled decarburization in an air blast, the method of the 'hundred refinings' Rather later, much of the Chinese steel was made by a 'co-fusion' technique in which wrought and cast iron were heated together in crucibles, the pasty lumps of the former being bathed in the high-carbon liquid By a gradual diffusion of carbon a steel of approximately eutectoid composition can be produced In connexion with this production of steel one is inevitably reminded of the work of Réaumur of the very early eighteenth century A D The basic correspondence of these processes with those of Huntsman, Bessemer and Siemens and Martin is clearly very much in the mind of Dr Needham Indeed, so far as the Bessemer process is concerned, he points out that immediately before the work of William Kelly in the United States, four Chinese workers were imported as experts at his furnaces at Kuttawa

Many other topics are discussed, from magic swords and human sacrifices to assist the furnace produce the required product, to early Chinese tilting furnaces, and the abundant footnotes are often a sheer delight

This book on the development of the iron and steel industry has a special interest in view of the present-day small-scale production of iron in China, often by processes which cannot differ essentially from those here described We must now await even more impatiently a corresponding treatment of the non-ferrous metals

F C THOMPSON

USE OF ISOTOPES IN ORGANIC SYNTHESES

Organic Syntheses with Isotopes

By Arthur Murray, III, and D Lloyd Williams Part 2 Organic Compounds labelled with Isotopes of the Halogens, Hydrogen, Nitrogen, Oxygen, Phosphorus, and Sulfur Pp ix+1147–2096 (New York Interscience Publishers, Inc , London Interscience Publishers Ltd , 1958) 188*s*

MURRAY and Williams have produced a valuable contribution in this second part of their compilation of organic syntheses involving the use of isotopes While Part I dealt with the synthesis of nearly 500 compounds labelled with carbon-13 and carbon-14, Part 2 is devoted to a similar treatment of syntheses involving the isotopes of 8 other elements, compounds of bromine, chlorine, iodine, nitrogen-15, oxygen-18, phosphorus-32, sulphur-35, deuterium and tritium occupying 30, 15, 65, 151, 33, 30, 82, 400, and 54 pages respectively The book provides full practical details, in a format rather like that employed in "Organic Syntheses", for the preparation of several hundred individual compounds Each preparation is headed by the reaction scheme laid out with full structural formulæ, together with the reference from which it has been abstracted Then follows the "Procedure", a section of explanatory "Notes" and finally "Other Preparations" in which the literature dealing with the preparation of the compound is briefly reviewed

The compounds are classified under the element concerned and sub-classified according to the chief functional group, for example, acids and acid derivatives, amines, heterocylics, hydrocarbons, etc With this arrangement rapid scanning of particular sections is feasible, and the book thus provides a ready source for the chemist searching not only for possible recipes to prepare isotopically labelled compounds but also for high-efficiency, small-scale syntheses for 'unlabelled' compounds. The largest single section is that describing the preparation of compounds containing deuterium, which is in itself a useful collection of experiments in view of the current interest in mechanistic studies. The sixty or so pages of tables listing the hydrogen-deuterium exchange data culled from the literature are most valuable. The less extensive exchange data for other isotopes are also presented in tabular form. Tables of physical constants for isotopically labelled compounds are given where appropriate.

It has evidently been decided that the reader must buy Parts 1 and 2 and use them in conjunction for the joint index is in Part 2 and the "Introduction" is in Part I. This is doubly inconvenient and seems false economy, as the inclusion of a repeat introduction and separate index could surely not have added much to the cost of these already expensive volumes. The "Introduction" (30 pages) in Part I explained the layout and scope, the new system of isotopic nomenclature used, the special experimental techniques employed, and has short sections on several other important topics. It is annoying to have constantly to refer to Part I for this information. Apart from this question and some minor errors, for example, on p. 1455, ethynyl benzene is consistently referred to as vinyl benzene, this book is an excellent one which should be invaluable both in the library and the laboratory. It should have something of value for all chemists. G. EGLINTON

PHARMACEUTICAL RESEARCH IN THE U.S.S.R.

Soviet Pharmaceutical Research. Vol. 1: Pharmaceutical Chemistry. Pp. ii+447. 95 dollars. Vol. 2: Pharmacognosy. Pp. ii+401. 90 dollars. Vol. 3: Medicinal Chemistry. Pp. 556. 100 dollars. (New York: Consultants Bureau, Inc.)

RESEARCH into subjects of a pharmaceutical interest is being actively pursued in the U.S.S.R., but communication, due to language difficulties, is virtually non-existent. Workers in this and allied fields will appreciate the enterprise of those responsible for the three-volume translation into English of 'Soviet Pharmaceutical Research". Most of this work seems to have been originally published in the U.S.S.R. during the period 1949–1953, but nevertheless it contains much of interest to present trends in pharmacy generally.

Being an American-inspired translation, British readers should not be misled by the title of Vol. 1, "Pharmaceutical Chemistry". This would be better entitled "Physical Chemistry applied to Pharmaceutics", since it contains reports on 74 research papers covering such topics as solubility, stability, ion exchange, emulsions, suspensions and gels, as well as such diverse topics as conditions for preparing crystalline glucose and an investigation of the causes of granulation of powders. Subjects worthy of note in this volume are the influence of organic additives on crystal solubility; patterns of solubility change; the thermal stability of collagen in the dry state; and the decomposition of the binary compound of glucose with sodium chloride. There are interesting investigations into several aspects of emulsion technology utilizing gelatin and also a classification of pigments by their behaviour in suspension. In the analytical field, papers describe the application of infra-red absorption spectra to an investigation of the intermediate products of vitamin A and carotene syntheses.

In Vol. 2, entitled "Pharmacognosy", the papers are merely classified under the headings alkaloids, oils and glycosides, there being no attempt to provide any further subdivision. Provided that the publishers' selection of material is representative of pharmaceutical research being undertaken in the U.S.S.R., it would appear that the isolation of new alkaloids, their proof of structure and possible synthesis are the main preoccupations. No work is included on the chemical constituents of well-known drugs with the exception of some studies on the alkaloids of aconite. Chemical investigations are reported on the alkaloids of *Delphinium*, *Senecio*, *Orobanche* and *Leontice* as well as on the alkaloids of lesser known plants. Some work is reported on the chemical analysis of a few little known essential oils, and there is a paper on the polarographic estimation of some cardiac glucosides, including strophanthidin.

Vol. 3, 'Medicinal Chemistry", consists of translations of 91 original research papers on various aspects of this field of chemistry. One group of papers deals with the structure and activity relationships in antimalarials of the quinoline and acridine series. One paper deals with the production of nicotinic acid from the heavy bases in coal tar (236.5–247° C. fraction), and the yield of commercial nicotinic acid is stated to be in the region of 25–35 per cent of the fraction employed. Syntheses of several anti-tubercular drugs like opianic acid derivative of isonicotinic acid hydrazide and several homologs of *p*-aminosalicylic acid have appeared for the first time. The syntheses of several alkaloids like papaverine and emetine have been elegantly described. The synthesis of compounds with antithyroid activity and the preparation of amino-alcohols similar to ephedrine are presented in two papers which will attract the attention of synthetic chemists. The synthetic work in the field of anthelmintics of the coumarin series, and the investigations into the reactions of mercapto-amino-acids will be appreciated by those who are engaged in this type of work. The work on the synthetic studies of methylene-*bis*-5-alkylbarbituric and *spiro*barbituric acids has met with partial success.

The synthetic work in the field of amino-acids such as the synthesis of B-alanine, tagged ^{35}S-methionine and ^{14}N-sulphanilamidolysine, will attract the attention of biochemists. The research work carried out in the chemistry of chloromycetin analogues should be noticed, as the compounds prepared have been found to be active. There are three papers which describe the structural chemistry of gramicidin *C*. A theoretical paper by Nazarov deals with the nomenclature of synthetic steroids and related substances.

In general, this compendium of translations of selected papers from Soviet chemical and pharmaceutical journals gives a fairly good idea of the modern trends of pharmaceutical research in that country. The editors and the publishers of the volumes deserve thanks for compiling and reproducing this mine of information, even at the moderately high price, for those connected with pharmaceutical research. D. TRAIN

Theoretical Physics

Thermodynamics, Electromagnetism, Waves, and Particles By Prof F. Woodbridge Constant (Addison-Wesley Physics Series) Pp xiii+364 (Reading, Mass Addison-Wesley Publishing Company, Inc , London Academic Books, Ltd , 1958) 64*s*

THIS excellent book is the second of two volumes on theoretical physics by Prof Constant The first volume treats mechanics and vector analysis and the second, thermodynamics, electromagnetism, waves and particles Vector methods are used throughout the second volume and frequent references to the earlier volume are made For these reasons, it is probably best to use both books together The vector equations in both volumes make use of the operator ∇ only, the shorthand terms grad, div and curl not being used The main disadvantage of the second volume for students in the honours schools of physics in English universities is that it does not go quite far enough , the level reached approximating to two-thirds of the way along an honours course On the other hand, students taking a general science degree would find the approach rather sophisticated as such students are not usually brought up to the use of vector algebra It would appear, therefore, that such an expensive text will not find favour with students at English universities Nevertheless the book is well planned and the consistent use of vectors seems to make for a logical presentation It is a book that will probably be used more by teachers of physics than by students of physics in Britain Text and diagrams are admirably clear and the binding is excellent Examples are given at the end of every chapter and answers to alternate questions provided

R M TENNENT

High Speed Computing

Methods and Applications By Dr S H Hollingdale (Applied Physics Guides) Pp xii+244 (London English Universities Press, Ltd , 1959) 25*s* net.

IN recent years the automatic digital computer has become available to a wide field of potential users, either directly or through the agency of various computing services It is to these users rather than to the computer engineer that Dr Hollingdale's book is addressed

After a brief introduction to the binary system and to the representation of numbers in a computer, the author devotes nearly one-half of the book to the problem of how a computer obeys a programme This theme is elaborated with special reference to *Edsac* and to *Deuce*, which are examples of a typical single-address machine and a rather less typical multi-address machine The circuit techniques of digital computing are confined to two short chapters on storage devices and the logical design of computing circuits

It is the final chapters of this book that many will find of greatest interest A valuable chapter on the operation of a computing service, written mainly from the author's experience of such a service at the Royal Aircraft Establishment, is followed by four chapters on applications In addition to general topics, these cover the Monte Carlo method, the control of industrial processes and the machine translation of languages

This book is thus in the main concerned with the operation of machines as a whole rather than of their component parts, while the mathematics assumed is not above ordinary level of the General Certificate Examination This approach provides an ideal introduction to the subject for potential user and non-specialist alike

E M DEELEY

The Chemistry of Vegetable Tannins

A Symposium (Being the Papers presented at a Symposium held in the University, Cambridge, on April 12th–13th, 1956, under the auspices of the Society of Leather Trades' Chemists) Pp 160 (Croydon Society of Leather Trades' Chemists, 1956) 30*s* net

IN view of the efforts made in the last decade to bring order to the vast and complex arena of tannin chemistry this volume of collected papers by leading authorities in this branch of organic chemistry is particularly welcome A general paper on vegetable tannins (T White) is followed by a detailed account of estimations of components of vegetable tannin extracts (H G C King and T White) Descriptive papers on gallotannins and ellagitannins (D Burton and H G Munster), polyphenols of tobacco (W W Reid) and paper chromatography of polyphenols of tea (E A H Roberts) together with an account of the work on the constitution of chebulinic acid (O T Schmidt) and a summary of aromatic biosynthesis leading to tannins (Hathway) complete the first section The second part of the symposium is devoted to papers on leuco-anthocyanins (T Swain and E C Bate-Smith ; W E Hillis), catechins of oak and sweet chestnut (W Meyer) and dihydroflavonols (J E Gowan, E M Philbin and T S Wheeler) The final paper (W B Whalley) consists of an account of the stereochemistry of chromans and related compounds I feel that another instalment of this symposium would now be most welcome, especially in view of the intense activity in the subject

A I SCOTT

Handbook of the Petroleum Industry

Edited by G Sell and H A Dossett Pp viii+213 (London George Newnes, Ltd , 1958) 25*s* net

AS the editors are at pains to stress, this is not a text-book on petroleum, but rather a guide to those of the younger generation who contemplate a career in this vast industry It proves of interest, too, to those oil technologists and others so engaged because of the modern overall picture it presents of the manifold ramifications of the industry Besides the editors, ten specialists have contributed sections, devoted to geology, history, exploration, drilling and production, world oil resources, distribution, refining, oil shales, tar sands, petrol from coal, oil as fuel, petroleum chemicals, uses and future prospects, careers in the industry and the industry surveyed as a whole Generally, in the larger oil organizations, the recognized inter-related divisions to-day comprise (*a*) exploration and prospecting, (*b*) drilling and production (*c*) transport and storage, (*d*) refining and petroleum chemicals, (*e*) research, (*f*) marketing and distribution Thus a candidate for a career in oil has a wide choice for his or her talents, depending largely, apart from educational attainments and bias, whether overseas travel and work in the more remote parts of the world make fundamental appeal "Oil is where you find it" , this little handbook tells much about this, as it does about what is done, once found, to make it of universal service to mankind

THE ROYAL SOCIETY

ANNIVERSARY ADDRESS*

By Sir CYRIL HINSHELWOOD, P.R.S.

AWARD OF MEDALS, 1959

Copley Medal: Sir Macfarlane Burnet, O.M., F.R.S.

BURNET is among the most outstanding workers in the field of the viruses. Since 1925 he has made a long series of contributions to knowledge of the bacteriophages and he has elucidated the phenomenon of lysogenesis. He has shown how study of the range of activity of phages against various bacteria can be used to classify not only the phages but also the bacteria themselves.

He has studied many viruses pathogenic for vertebrates. He has shown how psittacosis is endemic in wild Australian parrots, and has thrown light on the epidemiology of herpes and poliomyelitis. He is well known for his development of several techniques for cultivating viruses in living chick embryos and their application in immunological studies of viruses. He has also made studies on the agglutination of mammalian and avian red blood cells by a number of viruses and virus-products, thereby throwing fresh light on the reactions taking place between viruses and the surfaces of susceptible cells. He found that an enzyme produced by cholera vibrios has an action on blood cells similar to that of influenza viruses.

From 1947 until 1951 Burnet worked on the reaction between influenza viruses and the muco-proteins on cell surfaces, and considered the mechanism whereby a virus can infect a cell. Between 1949 and 1958 he and his collaborators occupied themselves with the theme of genetic recombination between influenza virus particles carrying different, recognizable, marker characters. The possibility of a sort of hybridization between two virus strains was established. Burnet has applied these ideas in an attempt to understand how changes in virulence are brought about.

During the past few years he has turned to the study of fundamental aspects of immunity and has offered in a recent book on the 'clonal selection theory' a novel explanation of antibody production based on the idea of somatic mutation. His ideas about the body's ability to recognize 'self' and 'non-self' to a large extent predicted later findings on immunological tolerance. He applies the new ideas to tentative explanations of auto-immune diseases, of cancer and of ageing.

While so prolific of work and ideas, he has been of outstanding value in the councils of Australian science.

Royal Medal (A): Prof. R. E. Peierls, C.B.E., F.R.S.

Peierls's earliest work was on the theory of the solid state, a field in which he remains a leading authority. He has played an outstanding part in the development of 'fundamental theory', that is, in the formulation of what are believed to be the most basic laws of physics from which all other laws of Nature should ultimately be derivable. The subject-matter of fundamental theory changes over the years. In the late 'twenties and early 'thirties the term was practically synonymous with the relativistic theory of electrons and photons, and even as a very young man Peierls, with Landau, made an important contribution to one of the deepest problems in this subject, that of the limits of observability of physical quantities. When in the mid-thirties Yukawa initiated meson theory and so brought nuclear physics into relation with fundamental theory, Peierls's predominant interest was also in this field. His work with Bethe on the deuteron and that with Kapur on the theory of the compound nucleus are important landmarks of the period.

More recently, Peierls has directed his main, though not exclusive, attention to the general theory of quantal fields and of elementary particles. His best-known single contribution to this rapidly developing topic is a paper on the general derivation of commutation relations for arbitrary field theory, the idea of which has since been built into a great deal of modern work.

For many years Peierls has been a leading exponent of fundamental theory in Great Britain and an outstanding leader in theoretical physics as a whole. In Birmingham he has created a large and extremely active school, and if to-day young British and British-trained theoretical physicists enjoy a great reputation and occupy leading positions, this is largely due to Peierls's work.

Royal Medal (B): Prof. P. B. Medawar, C.B.E., F.R.S.

Medawar's research has been on the biology of senescence, the problems of tissue grafting and the effects of cells upon each other. To these difficult and fundamental subjects he has brought order and clarity, and experimental approaches of great originality.

In some of his earliest work he measured for the first time a property that can be called the growth energy of the chicken's heart, by determining the amount of an inhibitor needed to stop growth. He showed how the rate of decline of growth energy can be interpreted to provide a measure of senescence, and in this and subsequent work he explored with great penetration and caution the various concepts of ageing.

Study of problems of differentiation led him to the hypothesis (with R. E. Billingham) that cells of the adult skin may actively transfer hereditarily transmissible characteristics to their neighbours. In spotted guinea pigs the dark areas may gradually encroach on the light areas, which contain pigment cells lacking the enzymes necessary for melanin formation. The encroachment was shown to be due to the 'infection' of the light cells by the genes of their neighbours

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* Delivered at the Royal Society on November 30.

Still more fundamental analysis of the problems of tissue inheritance and differentiation followed in Medawar's main work on tissue grafting A graft from one individual to another will not in general survive (except with identical twins) He showed that this was due to the fact that the graft induces the formation of an immune reaction by the host The power to react against homografts was, however, found to be prevented from developing if the host animal was injected very young with cells from the donor strain A mouse, 'tolerant' in this sense, could be made sensitive again if injected with cells from a live mouse of its own strain

Very recently Medawar and his colleagues have discovered ways of disintegrating cells ultrasonically without destroying their antigenic power By fractionation it was then shown that this power resides in the nucleus and not the cytoplasm and may be associated with compounds of deoxyribonucleic acid and proteins

These discoveries have thrown new light on the nature of the differences between individuals and open up important possibilities for their chemical analysis

Davy Medal · Prof R B Woodward, For Mem R S

Woodward is by general consent among the leading organic chemists of the world to-day His most important work has been in the field of natural products, and he has made major contributions to the elucidation of the structures of cantharidine (1941), penicillin (1945), strychnine (1947), sempervirine (1949), santonic acid (1949), patulin (1949), terramycin and aureomycin (1952), cevine (1954), magnamycin (1956), rauvomitine (1956) and gliotoxin (1958)

In the course of these studies he has contributed significantly to our understanding of biogenetic pathways, especially for strychnine and in steroid-triterpene relationships Characteristic features of his structural work have been the clarity and penetration of his reasoning and the extensive application of modern physical methods It was by his correlation of ultra-violet spectra with substitution patterns in unsaturated compounds (1941–42) that he made his first important contribution to chemistry The resultant 'Woodward Rules' have been invaluable, and his own subsequent use of ultra-violet and infra-red methods has been a model to organic chemists

Woodward's achievements in the field of synthesis are among the most spectacular features of organic chemistry in recent years His synthetic studies have included work on morphine (1951), and have resulted in the first syntheses of many other important natural products including quinine (1944), sempervirine (1949), patulin (1950), cholesterol and cortisone (1951), strychnine (1954), lysergic acid (1954), lanosterol (1954) and reserpine (1956) Not only are these syntheses notable for their elegance in conception and execution but also they have done much to bring stereospecific reactions into general use in the synthesis of complex molecules and have greatly influenced all recent work in this field

The scope of his work is further indicated by his demonstration of the aromaticity of ferrocene (1952), his work on reaction mechanisms, especially of the Diels–Alder additions, and most recently his contributions to our understanding of the theory of optical rotatory dispersion

Hughes Medal Dr A B. Pippard, F R S

Pippard has made outstanding contributions to low-temperature physics, and he must be considered one of the leading experimenters in this field He has combined first-rate experimental work with a mastery of theory

Starting with superconductivity, Pippard introduced an important modification to the London theory, a phenomenological description of the electromagnetic properties of a superconductor, which for many years has been an important guiding light in the subject He was led to this modification by his own experiments on the depths of penetration of currents in superconductors These were explained by the postulate of long-range wave-functions and thus non-localized effects, the current density at a point depending on the integral of the vector potential over a region (of about 10^{-4} cm) Later developments in the fundamental theory have tended to confirm the correctness of Pippard's conception

He also studied the anomalous skin effect in non-superconductors and gave a simple but complete picture of what happens when the mean free path of the conducting electrons is large compared with the skin-depth of penetration of high-frequency currents

More recently Pippard has carried out detailed measurements, again at high frequencies, on the surface resistivity of single metal-crystals, analysing the variations which occur in different directions related to the crystal axes In his work on copper, he has shown how such measurements can lead to a plot of the 'Fermi surface' of the metal By this is meant that a contour can be plotted of the way in which the positions of the valence electrons of highest energy are woven into the crystal-lattice structure This adds to our knowledge from X-ray crystallography of the lattice structure of the nuclei in a crystal, fundamental information about the geometrical pattern of the electrons

Pippard's work is characterized by deep originality, coupled with experimental ingenuity and a profound theoretical insight into his subject

THE INTERNAL AND THE EXTERNAL WORLDS

There has been no slackening in the flow of significant discoveries from the world of science The most spectacular event of the recent past has been the transmission from the Russian *Lunik* of photographs showing the remote face of the Moon, an achievement acclaimed equally by the layman and the man of science In a more recondite way interest has been aroused by an electrostatic theory of cosmological expansion, and in contrast with these escapes, in action or thought, beyond the bounds of the Earth, plans have been made for unprecedentedly deep drilling into its interior Syntheses such as that of coenzyme A and of 6-amino penicillanic acid have further strengthened the alliance of organic chemistry and biology, and the production of specific forms of deoxyribonucleic acid outside a living cell but primed by the presence of existing deoxyribonucleic acid has been another step towards the understanding of the material basis of life

Any of these things, and indeed many others, might well form themes for a presidential discourse, but with a special end in view I shall single out for mention one or two isolated and indeed rather specialized samples. These are chosen because they not only involve fascinating discoveries but also because they lead us to ponder once again on deep questions which should not be ignored by the contemporary man of science. They relate, in fact, to the concomitance of the inner world of conscious experience and the outer world of Nature. This extraordinary problem is always with us; but the unexpectedness of the new observations, though it does not really disclose new kinds of mystery, does reawaken us to awareness of something, the strangeness of which familiarity tends to dull.

The social life of insects cannot but fill the onlooker with wonder, and arouse speculation about the conscious elements which may lie behind the behaviour manifest to an observer. Nobody intimately acquainted with individuals among the higher animals can seriously doubt that they possess some inner life, perhaps not entirely unlike our own. But that of the insects is by our standards likely to be very peculiar indeed; yet there is in all probability an intelligible pattern to it. The Rothamsted work on the 'queen substance', transmitted from the queen bee to the other members of the hive, shows how this chemical compound regulates the whole reproductive process of the bee community and dominates the organization of their lives.

The inward concomitants of the observed behaviour we can scarcely imagine, and indeed the control of highly complex individual and communal actions by a chemical substance could easily suggest a purely behaviourist view of living creatures, and lead to the denial of the internal world altogether. This I believe to be philosophically wrong.

Another recent research provokes us to think about the matter, as it were in the reverse order. We are familiar enough with human colour vision and can scarcely doubt the existence of this as a personal experience. The external conditioning of it has recently been stated by Land to differ very surprisingly from what had been supposed, and to be of a quite extraordinary character. The essential experiment is made in the following way. A coloured scene is photographed by means of a split-image camera simultaneously through two filters, one of which cuts off the upper half of the visible spectrum and the other the lower half. Two black-and-white positive transparencies are thus prepared. These are projected separately each with a different monochromatic light, for example, two yellows differing in wavelength by a few hundred angstroms, and the images are recombined. The resultant produces in the observer the whole gamut of colour sensations. Thus information can be supplied to the brain so that, as Land puts it, "the eye functions to see full colour in a universe involving only a narrow wavelength band".

The question of the relation of the internal to the external world is again brought into sharp relief by these remarkable findings.

The topics I have mentioned can, of course, be treated without specific reference to these problems, but they lose a great deal of their interest if the implications about consciousness are ignored or denied. There is indeed one group of researches, carried further during the past year, in which these implications cannot possibly be evaded, namely, those in which physiological stimulation of the conscious brain is correlated not only with the behaviour of animals but also with the psychological experiences of a human subject.

The central problem of mind and matter is not always thought worthy of their attention by men of science, yet it was given profound consideration several decades ago by Sir Charles Sherrington, and we are vividly reminded of it in the most recent book of one of our senior Fellows, Lord Russell. At a moment, too, when Darwin is again very much in our minds, there are certain aspects of the whole matter about which it is highly important to think clearly. The question raises a still more general issue which I should first like to consider. There are few worse condemnations of a theory than to label it metaphysical, a term suggesting the attempt to arrive at truth by speculation divorced from experiment or to interpret reality by statements empty of scientific sense. Little enough enlightenment is afforded by such an assertion as that the orbit of a heavenly body has a given geometric form because this constitutes the perfect figure. Scientific theories are properly expected to account for many things in terms of few, to predict new phenomena or to yield verifiable, quantitative results. Yet too austere an application of this principle can segregate the world of science from the general world of intelligent appreciation, an unfortunate event at a moment when there is growing realization of the interest of science to the community at large.

Most men of science would disclaim any great concern with philosophy and especially with metaphysics. But what is metaphysics ? In the last resort it is the search for a statement subsuming the ultimate nature of all reality. Science has more modest hopes, and modern physics led the way to a considerable renunciation in this respect which has had a profound influence on philosophy itself.

Yet in science the total neglect of philosophical aspects may be unfortunate. It can lead, on one hand, to statements which are sensational but unsound, and, on the other, to an unhealthy indifference to the relationship of science to existence in general, and in any event, even though science may seem to decline metaphysical statements, it not only throws out challenges to philosophy but also is frequently itself confronted with problems inescapably philosophical in nature.

Scientific theories, though less ambitious than the systems of the older philosophers, and though claiming neither universality nor finality, do aim to be comprehensive and do hope to stand the test of time as long as possible. Moreover, we do judge them by a criterion in which it would be hard to disclaim every metaphysical tinge, namely, by the degree of mental and æsthetic satisfaction they afford. However much we may protest, utility is not enough. There is, undeniably, in the law of gravitation some quality distinguishing it from a set of empirical formulæ, however convenient. Men of science do, unconsciously at least, place hypotheses about Nature in a sort of hierarchy of esteem, where the conservation of energy and the second law of thermodynamics rank high and mere working rules rank low.

The difficulty of complete aloofness from philosophy is illustrated by parts of physics. The theory of relativity dominates cosmology and defines the relationship between matter and energy. The quantum laws and the Pauli principle provide the foundations of chemistry. Yet these powerful and productive generalizations involve distinctly metaphysical elements Although it seems to have been relatively late in the development of thought that a clear distinction between subject and object, between the external world and the observer was recognized at all, for most men of science there was not much question about it at the beginning of the present century Einstein, however, asserted the meaningless character of space and time abstracted from operations with measuring instruments and clocks and thus established the observer as an indispensable participant, whose status was increased by the 'uncertainty principle'

According to the Pauli principle, observability becomes identifiable with the very possibility of existence Thus the foundations of inanimate Nature can scarcely be discussed without recognition of the inadequacy of earlier spatio-temporal descriptions of reality, and without admission that subject and object had been in some respects too crudely separated

The fundamental laws of quantum physics can be summarized in the wave equation and in a set of rules for its operation Some people, it is true, say that they are content to accept these without deeper inquiry But in fact every one, whether he admits it or not, seeks something which he calls understanding The professed empiricism about wave mechanics is half-hearted, and more often than not the abstract mathematical formulation is given a metaphorical translation in which symbol and reality become very much confused 'Waves of probability' are created, electrons become 'clouds', potential barriers are 'tunnelled through'

When sound metaphysics goes, the seven devils of bad metaphysics soon enter to fill the gap and give an illusion of clarity Metaphors which may be helpful in illustration easily take control when the abstractness of the mathematical formulation becomes too austere, a fact which bears witness to the insistent demand of the mind for satisfaction by something beyond utility

Incidentally it may be remarked that if the more serious and responsible men of science remain aloof from the task of relating their subject to its philosophical background, the less serious and responsible will do it for them, and will startle the uninitiated with fantastic paradoxes which may impress the layman, but do science real harm The discovered facts of Nature are mysterious and impressive enough in their own right That light seems to recede from relatively moving observers at the same rate that the universe may look much the same from anywhere that measured mass may vanish into energy of radiation that states of energy form a discontinuous series that indistinguishable particles cannot co-exist that in the world of small enough dimensions particles and waves lose the significance suggested by macroscopic analogies none of these needs dressing in sensational form to make its impact on the thoughtful mind

Nor, on the other hand, are they merely to be made the basis of formulæ for the sole purpose of computations In the last resort what men of science search for is the vision of Nature, and this must be expressed and communicated in those terms which provide the nearest approach to real understanding

If this is true of the physical sciences, it is equally so of biology One of the transitions from physics to biology is illuminated by a remark of Heisenberg "The mathematical formulæ indeed no longer portray nature but rather our knowledge of nature"

The question, then, of the relation of the internal and the external worlds cannot and should not be ignored by men of science

It is surprising that biological discussions often under-estimate human consciousness as a fundamental experimental datum In science we attach no value to unverifiable deductions, or to empty qualitative statements, but nobody defends the neglect of experimental data Among these we cannot validly disregard those of our own consciousness except by a deliberate abstraction for which we must assume responsibility, and which we should not forget having made

It is tempting to ignore observational facts when they seem intractable, since we rightly abstain from the attempt to arrive at the truth by speculation But in this we are not always consistent, and indeed very important philosophical conclusions are sometimes propounded by men of science Moral and æsthetic qualities in man, for example, are not infrequently said to be explained by the operation of natural selection Again, it is sometimes asserted that suitable combinations of machines could, in principle, produce results indistinguishable by any operational test from animal or even human behaviour

The mind–matter relation is quite often dismissed as non-existent or meaningless But moral qualities are not explained by natural selection, human behaviour is not machine-like and the mind–matter relation cannot be ignored in an intelligent consideration of existence

The approach to the problem of consciousness must admittedly be egocentric I have to begin logically with the, to me, indisputable fact that I have a wide range of conscious experiences (which are indeed more important to me than anything else) The significance of this fact can be questioned in two ways first, by the objection that so far as any operational test goes other people may well be behaving simply as machines, and secondly, by the assertion that my consciousness is a more or less irrelevant concomitant of behaviouristic reactions

I am, it is true, not certain that other people have consciousness Neither indeed am I certain that the atomic nucleus exists But I regard its existence as in the highest degree probable I regard consciousness in other people as equally probable and for similar reasons The atomic nucleus is not directly observed It is inferred by elaborate reasoning from many complex experiments, any one of which could probably be given alternative interpretations What carries conviction is the fact that a coherent body of doctrine emerges from large numbers of varied tests

We are all the time trying experiments on our relations with other people, informing, asking, ordering, obeying, resisting, with varying emotions which are correlated with our actions Human evolution has developed an elaborate and sensitive communication system, brought into play in innumerable ways The hypothesis that other people have an interior life not unlike my own enables me to register correspondences at point after point in so intricate a way that I accept the hypothesis, if not as absolute truth, then as something nearly as good And with most of the basic conclusions of science I am in no position to demand more

Thus the content of consciousness must rank as something directly experienced by everyone, and therefore as providing observational data. This conclusion is not changed in the least by the consideration that the development of communication between individuals confers a biological advantage and is favoured by natural selection in so far as mutual assistance and the transmission of acquired knowledge can assist survival. The communication mechanisms exist and one of their uses is to enable us elaborately to test the coherence of predictions from the hypothesis that conscious life is on the whole much the same for different people. People like poets and novelists describe this inner life: their writings serve little enough biological purpose, but they are (sometimes at least) intelligible to the rest of us, and evoke memories of our own experiences, which check as significantly as those coincidences of calculations and dial readings on which we base our views about the physical world.

Nor can the observational data of consciousness be relegated on the ground that they are on the whole qualitative rather than quantitative. Science has to come to terms with qualities, and indeed Weisskopf has pointed out that the quantum theory itself introduced fresh qualitative distinctions into a region where classical physics expected only quantitative differences.

The conscious experience is sometimes set aside as supernumerary and irrelevant, on the ground that a machine can perform actions indistinguishable from those of a man (or with greater technical perfection could do so). The answer that machines like the so-called electronic brains work only to a 'programme' brings the rejoinder that a set of machines could itself be programmed by another machine. But the master machine would itself need a programme. This would have to be provided by another machine, and so on in an infinite regress, there being no way in which the sequence could be closed to a self-contained cycle.

The contention that a human being is a system of self-programming mechanisms seems to depend upon the error of neglecting relevant observational facts, those of consciousness belonging to precisely this category. In its higher functions the human brain is programmed, not by other mechanisms, but by æsthetic and moral elements which somehow have their seat in the consciousness, by elements, that is to say, which belong to the half of reality concerned with the observer rather than the observed. Of the concomitance of consciousness with brain processes there is no doubt, but concomitance does not mean identity. Changes in the electron-levels of an atom are associated with the emission of light quanta, but a photon is not a difference of quantum states. Nor in a concomitance of A and B is it justifiable to assert that A is the cause of B without admitting the possibility of a reciprocal relation. In particular, if we assert that physical happenings in the brain can affect consciousness, we must admit in principle that physical happenings in the brain may be consciously caused.

But it is an abstraction to speak of either category in isolation. For many purposes the two may be separated as a legitimate approximation, but this does not mean that they can be regarded as independent.

In parts of biology questions of consciousness are not of direct importance but cannot in general be set aside. Behaviourism might give a good approximation in describing the actions of intercommunicating individuals in a group, but it ignores the experimental datum, known to each individual about himself, and, by the coherence argument, about others, that in their conscious minds what men individually think or feel is of far more importance to them than any mechanical part which they may play in the biological community.

There is, of course, a clear enough meaning in the statement that consciousness and moral and æsthetic feelings are developed by evolution and natural selection. The power of conscious reasoning increases the chance of individual survival: social instincts favour the survival of the community, and are related to moral feelings. Æsthetics enter deeply into intellectual activity. There need be no difficulty in agreeing that these things have selective advantage. But the recognition that something present will be selected gives no clue whatsoever to its actual nature or genesis. For the purposes of natural selection a purely unconscious reaction of the brain and nervous system would have sufficed. Beneficial reactions indeed need have no conscious counterpart, as is widely evident in human physiology. But behaviouristic descriptions in general are models and abstractions ignoring data which, so far from being trivial and irrelevant, are the only things which make us *inter alia* concern ourselves with science at all. In any event, if free will, moral feelings and other conscious elements are illusions superposed on a behaviouristic background, wherein can lie their selective advantage?

There is at present no obvious answer to the question of what kind of advance can possibly be hoped for in the problem of psycho-physical concomitance. This, however, is no reason for giving up thought which at least helps to avoid the kind of errors so easily made both about physics and about biology when the problem is ignored.

It would, moreover, be a mistaken policy for men of science to withdraw from the inquiry. Lucretius might well have been asked how any real knowledge of his primordial particles could ever be obtained and would have been unable to answer. Before Galileo and Newton there were no appropriate concepts in terms of which to understand the flight of a projectile. At one time the rusting of iron must have seemed a process *sui generis*. The discoveries of science and the evolution of its grammar go hand in hand. Negative predictions are discredited by the famous pronouncements of Comte: "Toute recherche qui n'est point finalement réductible à de simples observations visuelles nous est donc nécessairement interdite au sujet des astres. . . . Nous concevons la possibilité de déterminer leurs formes, leur distances, leurs grandeurs, et leurs mouvements ; tandis que nous ne saurions jamais étudier par aucun moyen leur composition chimique."

In the earliest times the description in rational terms of physical Nature was not so much an unsolved problem as one which people did not even conceive.

Human knowledge will not be in a satisfactory state until the dichotomy of the internal and the external is somehow removed.

In one way the man of science, because he starts by demanding least of an explanation, is the most likely to succeed in finding it. The question might be asked: What happens when an atom emits light? The more naively this is considered the less is an answer possible. But the laws governing various correlations, change of atomic state with quantum emission, or quantum with field have been formulated in terms of concepts appropriate to the problem, and they yield satisfaction not only by making possible quantitative predictions but also by an inherent elegance Eddington once discussed the way in which the terms of physics link together in endless cycles and pointed out that in one way Newtonian mechanics constitutes a vast tautology This is often true in so far as physical theories create, as it were from nothing, a series of definitions and concepts by the aid of which things previously intractable are brought together into order and intelligibility

In the light of this analogy, the further exploration of the concomitance of the internal and external worlds appears less permanently hopeless The right grammar and language need to be evolved In the process the present bounds of science may expand, but they have never been established by a firm decree Chemistry and physics have united with biology and penetrated regions once thought inaccessible Physiology is already allied with psychology and together they may search in strange and hidden places There will no doubt be difficulties of which Freud's struggle for acceptance provides a warning example, but it may be recalled that chemistry and physics themselves arose from a welter of charlatanry magic and surmise as the correct language in which to describe their phenomena grew up There are so-called para-scientific aspects of biology and psychology, which to-day show all too often the discouraging characteristics of the worst days of alchemy Yet the history of chemistry warns against a final condemnation

In the meantime those numerous studies are to be welcomed which, without solving the central problem, keep it constantly alive observations on individual and communal behaviour in animals, on perception and illusion investigation of the processes of learning and memory, construction of machines which imitate the mental functions, search into the phenomena of sleep Above all, there lies hope that sooner or later to the eye of genius some quite ordinary phenomena will reveal, like the fall of Newton's apple, an undreamt of but thenceforth obvious significance

THE SHAPE OF PROTEIN MOLECULES SUGGESTED BY ELECTRON MICROSCOPY

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THE weights of most of the important protein molecules are now known with a fair degree of certainty Apart, however, from some of the fibrous proteins such as collagen, speculation about their shapes and sizes is less surely based The weight of a protein molecule when multiplied by the readily determined value for its partial specific volume gives the volume of the anhydrous molecule Therefore, if protein molecules were compact spheres, their diameters would be known, and values calculated in this way from available data[1] are listed in Table 1 for various proteins But a diameter can also be calculated[1], again on the assumption of a spherical molecule, from the hydrodynamic behaviour of the protein, in particular from its rate of diffusion and sedimentation in the centrifuge and the viscosity of its solution In almost every case this diameter comes out to be significantly larger than that indicated by the molecular weight, the ratio of the two values giving the frictional ratio for the molecule There are three possible explanations for the discrepancy, that is, for frictional ratios greater than unity (1) the molecules may carry water either internally or as a surface layer, and thus behave in solution as larger objects than the calculated compact anhydrous size , (2) the molecules may be elongated rather than spherical , (3) the hydrodynamic formulæ involved in the calculations may not be strictly applicable to protein molecules

The third explanation is not always considered, but in fact there is no compelling evidence that molecules behave like smooth, rigid bodies, as theoretically required , nor indeed any direct evidence that the formulæ used are valid for objects as small as a molecule The two other possible explanations are usually both taken into account and lead in the following way to a picture of the molecular shape The extent to which proteins are hydrated is not easily measured, but 0 3 gm water bound per gm protein is thought in most cases to be a good estimate Assuming some such figure, one can next calculate from theory[2] the ratio of the length to the width of the molecule that would then account for its behaviour Table 1 shows the results of these calculations The molecules are assumed to be ellipsoids—either prolate (cigar-shaped) or oblate (disk-shaped)—but provided the structure is rigid, the length-to-width ratios are not critically dependent on the exact model Except for ferritin, all the proteins listed come out to be distinctly elongated, and it is as long prolate ellipsoids that these protein molecules are usually visualized

The electron microscope, with its limit at a resolution of 15 A , ought now to be capable of confirming these theoretical deductions by showing the shape of the anhydrous molecules directly on a photographic plate That it does not do so is due to the low electron-scattering power of proteins, and in practice no untreated molecule with a molecular weight less than about 2 million can be detected at all However, the contrast is greatly increased by metal shadowing and in this way Hall has obtained some fine pictures, for example, of catalase[3] and fibrinogen[4] But such pictures require exceptional technical skill, and as usually employed the metal coating is too grainy to give a reliable picture In addition, the structure of the supporting film is inevitably brought out and can cause confusion But even allowing for these difficulties, it is curious that in every attempt so far published the electron microscope has failed to show the expected elongated forms of the protein molecules

A method that shows very fine detail on the surface of virus particles has recently been developed by Brenner and Horne[5,6] and which they have termed

Table 1

Protein	Molecular weight	Volume of compact anhydrous molecule ($A.^3 \times 10^{-6}$)	Diameter of molecule if a compact sphere (A.)	Ratio length/width of molecule to account for behaviour if 30 per cent hydrated	Hydration required to account for behaviour if molecules are spheres (per cent)
Glutamate dehydrogenase	$1·0 \times 10^6$	1·25	134	3·5	95
Thyroglobulin	$6·3 \times 10^5$	0·76	113	4·2	120
Urease	$4·8 \times 10^5$	0·59	104	3·2	85
Ferritin	$4·7 \times 10^5$*	0·59*	110	1·0	30
Legumin	$3·8 \times 10^5$	0·46	96	7·0	230
Catalase	$2·5 \times 10^5$	0·31	84	3·4	90
γ-Globulin	$1·6 \times 10^5$	0·20	73	5·9	190
Serum albumin	$6·6 \times 10^4$	0·08	54	3·4	95

* Figures refer to the protein component of ferritin which in addition contains 20 per cent iron.

'negative staining'. Using spray droplets, they partly embed the virus in a layer of neutralized phosphotungstic acid and the relatively transparent objects appear with great contrast against a nearly opaque and structureless background. This is the reverse of the usual appearance and 'negative contrast' is perhaps a better description of the effect achieved. It seemed that a similar method might also be useful for showing up the larger protein molecules. For this application the original procedure was modified as follows. The protein at concentrations of between 0·1 and 1·0 mgm. per ml. was made up in 0·02 *M* phosphate buffer *p*H 7·8 and an equal volume of 1 per cent sodium tungstate added. The technique depends essentially on avoiding any interaction between the tungstate and the protein, and for this reason the *p*H was maintained well above the isoelectric point. It was found helpful for the electron microscopy to add polystyrene latex spheres of 0·2μ diameter[7], which can be seen easily on the screen in negative contrast (that is, bright on a dark background), if the preparation has been satisfactory. The protein solution is sprayed on to the specimen supports exactly as described by Williams and Backus[8]. When the electron micrographs of the preparation are examined, the protein molecules appear as clear points in 5–20μ droplets of dark structureless material. The procedure is rapid and some of the risk of distortion by surface forces is avoided since the drops set rather than dry. The molecules should be well preserved, and in fact simple tests have shown that proteins dried in the droplets and then re-wetted are still largely undenatured (for example, enzymes remain active).

Experiments with purified preparations of the larger proteins soon showed that while some gave pictures of high contrast, demonstrating convincingly the power of this new technique, others were almost equally disappointing. This was not related to molecular size, for in fact some of the smaller molecules appeared with the greatest clarity. The difference may possibly lie between proteins that are internally hydrated and those that are not. The tungstate can penetrate very small holes (this sort of technique was first used to demonstrate the 15 A. hole along the axis of the tobacco mosaic virus rod[9]) and any molecule having an open sponge-like structure may fill with tungstate and be almost obscured. Although preventing good pictures of some interesting proteins from being obtained, this penetration may indicate which molecules have extensive internal hydration.

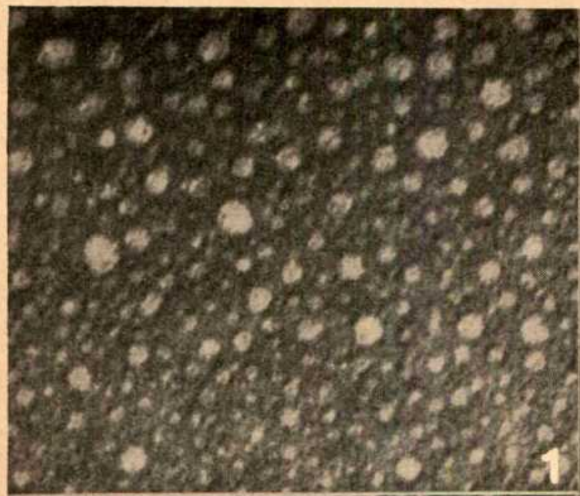
The proteins listed in Table 1 were all examined by this negative contrast technique, and some of the pictures obtained are shown in Figs. 1–6. Points particularly noted about each are now discussed.

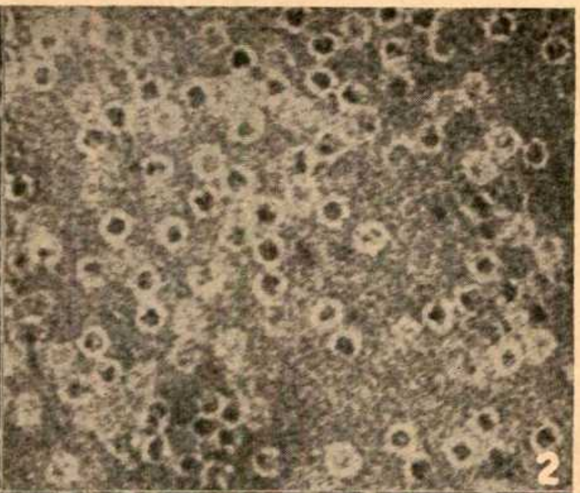
L-*Glutamate Dehydrogenase* (*Glutamic Acid Dehydrogenase*). The unusual behaviour of this protein in the ultracentrifuge[10] has suggested that the molecule can dissociate reversibly on dilution into smaller units. Similar dissociation has also been observed in the presence of substrate[11], while in the presence of coenzymes re-association occurs[12]. The molecular weight of the undissociated molecule has been measured as 1,000,000 (ref. 10), and it is suggested[11] that this represents a tetramer that can split into a dimer and then a monomer. Our electron micrographs lend support to these ideas. The objects seen varied in size, depending on the concentration at which the protein was sprayed. At suitable dilutions (about 0·5 mgm. per ml.), three sizes of roughly spherical objects could be seen (Fig. 1) measuring 125 A., 90 A. and 75 A. The cubes of these numbers (which give a measure of volume) are almost exactly in the ratio 4 : 2 : 1. Smaller debris was also usually present. The largest objects appeared slightly smaller than the size of 134 A. calculated for a molecule of the molecular weight reported, but the difference might not be significant. While these electron micrographs certainly support the picture of the molecule as a tetramer, they do not suggest a simple aggregate of 4 units. On dissociation, the molecule appears as if it has broken into two or four equal pieces which have re-formed into round irregular shapes. Thus although dissociation is said to be accompanied by a fall in axial ratio[11], there is no obvious change in shape to account for this.

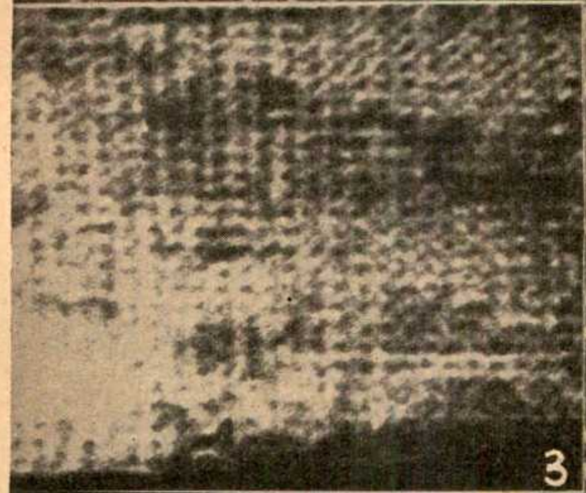
Thyroglobulin. Despite its large molecular weight, the molecules of this protein were almost indetectable by the negative-contrast technique. Vague round objects measuring about 140 A. across could just be made out, and objects of similar size were seen in metal-shadowed preparations. It may be that this molecule has an open structure that is easily penetrated by the sodium tungstate and occupies a volume roughly twice that calculated for a compact molecule of this weight.

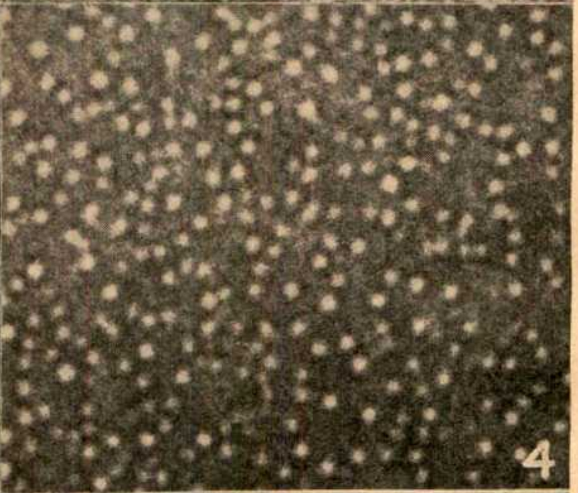
Urease. The molecules were similarly scarcely detectable. A diameter of about 130 A. was suggested, again giving a volume almost twice that of a similar compact molecule.

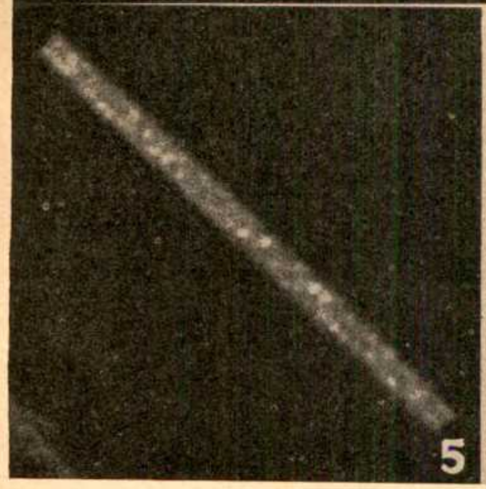
Ferritin. The structure of this molecule deduced from X-ray scattering has been described recently[13] and the findings correlated with previous work. The molecule contains 20 per cent iron (as ferric hydroxide) at its centre, this iron being free to move in and out











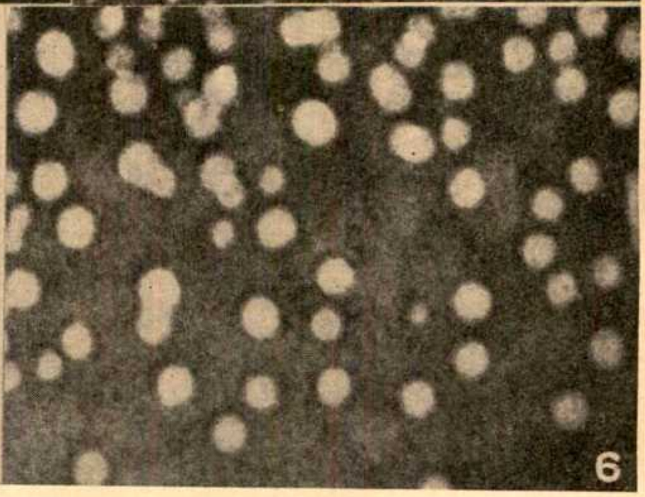


Fig. 1. Molecules of L-glutamate dehydrogenase. × 400,000

Fig. 2. Molecules of ferritin. × 400,000

Fig. 3. Molecules of catalase in a small crystal. × 400,000

[Fig. 4. Molecules of γ-globulin. The centre to centre spacing of molecules that touch is 70 A., but the extreme edge of the molecules is not clearly shown on the print. × 400,000

Fig. 5. Tobacco mosaic virus rod with molecules of γ-globulin antibody on its surface. × 250,000

Fig. 6. Molecules of macroglobulin. × 400,000

without disarranging the protein shell The form of the iron core has already been studied with the electron microscope[14] and its varying appearance interpreted as differing aspects of four closely spaced micelles The negative contrast pictures (Fig 2), while still clearly showing the central masses of iron, give a better picture of the outline of the surrounding protein Some of the molecules can be seen to be partly or completely deficient of iron The protein shell is about 25 A thick and the diameter of the molecules measures 110 A

Legumin A sample of this plant globulin was kindly supplied by Dr P Johnson (Department of Colloid Science, Cambridge) and the full physical data and findings will be presented elsewhere The negative-contrast technique showed the molecule as a short cylinder 85 A in diameter and 85 A high A hole 15 A wide was seen to run along the axis from one end of the molecule to the other The volume of such a solid corresponds closely with that calculated from the molecular weight, but the electron microscope again completely fails to show the asymmetrical shape required to fit the hydrodynamic data

Catalase The molecules of catalase appeared as slightly elongated rings or as two parallel lines, suggesting end-on and side-on aspects of a hollow approximately cylindrical shape The identification of such objects as catalase molecules was confirmed by obtaining pictures of the surface of small crystals of the protein (Fig 3) The same ring-like forms can be seen in orderly array, the molecules measuring 60 A across their short axis and 85 A across the long one The molecules in the crystal appear to interlock almost completely, not just to touch , thus the width is very little greater where two rings meet in the crystal than it is in a single ring in isolation This may suggest that the molecule has some sort of helical form that allows the surfaces to interlock The height of the molecules cannot be deduced from the electron micrographs of the crystal, but measurements of isolated molecules seen on their sides suggest a height of 70 A From metal-shadowed pictures of catalase crystals, Hall[3] has deduced a height of about 60 A The thickness of the ring when the molecule is seen end-on is about 20 A and this figure with a height of 70 A fits well with the molecular weight of 250,000 The suggested shape is also consistent with Hall's pictures of catalase molecules[3], but the granulation in the metal shadowing partly masks the appearance of rings, and as a result he interpreted the electron micrographs differently

γ-Globulin The molecule is traditionally pictured as cigar-shaped with a length-to-width ratio of about 5 : 1 The negative-contrast technique shows a perfectly round molecule of diameter 70 A (Fig 4) Similar molecules were seen attached to viruses after treatment with specific antiserum Fig 5 shows a tobacco mosaic virus rod after such treatment and a number of γ-globulin molecules (antibodies) can be made out on its surface

Serum Albumin Repeated attempts to show the molecule of albumin in the same way have failed All that has appeared are vague round forms 70 A in diameter and objects too small to be the intact molecules measuring 30 A A possible suggestion is again that this molecule has an open structure largely penetrated by the sodium tungstate

Macroglobulin A sample of globulins from a pathological serum was examined In the ultracentrifuge this had shown, in addition to the usual γ-globulin peak, other peaks at 16 2 *S*, 22 5 *S* and 29 6 *S* The electron micrographs of this material (Fig 6) showed various sizes of spherical molecule with diameters close to 70 A (normal γ-globulin), 100 A , 125 A and 150 A

This preliminary survey of protein molecules with the electron microscope has clearly shown two points The first is that the negative-contrast technique is a valuable method for showing the shape of many molecules, and the possibility of studying molecular interactions in the same way is opened up Secondly, the question that has frequently been raised of late as to the significance of the frictional ratios calculated for molecules is now even more in dispute In the case of ferritin, the values obtained[15] for the sedimentation and diffusion constant fit well with the observed nearly spherical shape (the axial ratio calculated was originally given as 3 4, but this seems to be an error) The nearly symmetrical but not spherical shapes found for catalase and legumin would have an undetermined effect on the frictional ratio, but could scarcely give values as high as those actually found The loose open structures proposed for thyroglobulin, urease and albumin might, however, have high frictional ratios But in the case of γ-globulin a perfectly spherical form behaves as an ellipsoid five times as long as it is wide , to account for this a hydration of almost 200 per cent would have to be proposed and this will generally be considered an impossibly high figure If one is not to conclude that frictional ratios bear little relation to shape and merely indicate the degree to which classical hydrodynamics is inapplicable to the molecules, only one alternative seems to remain It is possible, as Hall has suggested for fibrinogen[4], that the symmetrical objects seen with the electron microscope are only units of the molecule and are joined in pairs or trios by undetectable links Thus γ-globulin could possibly be a dumb-bell-shaped molecule with its spherical ends linked by perhaps a single protein chain that would remain unseen if less than 10 A wide Study has, however, so far quite failed to produce any evidence in favour of such pairing of units With all the proteins studied here, the electron microscope in fact suggests various almost symmetrical but not always spherical shapes

I am grateful to various colleagues, Dr A S McFarlane, Dr J R Tata and Dr. A C Allison, for samples of the purified proteins used in this work, to Dr P A Charlwood for ultra-centrifuge data on the macroglobulin and to Miss B Cooling for help with the electron microscopy

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OBITUARY

Prof. C. T. R. Wilson, C.H., F.R.S.

At the time of his death, and in relation to date of election, Charles Thomson Rees Wilson was senior Fellow of the Royal Society by four years. He was elected to the fellowship in 1900, and, indeed, of those elected in the decade 1900–10, only three survive him. He received the Hughes Medal in 1911, a Royal Medal in 1922, and the Copley Medal in 1935. Eight years previously he had shared the Nobel Prize for Physics with A. H. Compton. This bare recital of fact tends to obscure the man in the record of history: it closes in the year which followed his retirement from the Jacksonian professorship at Cambridge, and his return to Edinburgh—and Scotland. It obscures C. T. R. the man, who endured, until the end, bright-eyed, nervously alert, long of stride, young of heart, serene through a quarter of a century of conflict and change which passed him by.

His years of retirement were not empty. Soon after his eightieth birthday, he moved from Edinburgh to the village of Carlops, close to his birthplace at the farmhouse of Crosshouse, at Glencorse; but regularly thereafter he made the journey to the city by bus so that he might lunch with friends, physicists and others, many of half his age or younger, once a week in a crowded restaurant. Scientifically, too, his retirement was fruitful: some four or five years ago he began again to write the long-promised account of his theory of thundercloud electricity, and finally, on April 27, 1956, the manuscript was lodged with the Royal Society. It was published in the *Proceedings* in August of the same year: twenty pages of closely reasoned statement—emphatically a work of the present, not of the past. Nor was he home-bound: he attended a dinner in his old college at the time of his eightieth birthday and, when the reactor *Dido* was inaugurated at Harwell in November 1956, he was among the guests. It was my privilege to be his travelling companion on that November day. Rising about 5.30 a.m., he was in Edinburgh soon after seven; we made the return journey to London Airport by B.E.A. *Viscount*; it was nearly 11 p.m. before he was home again. In the meantime, everything that there was to be seen he had seen; he had climbed all the ladders and looked into all the peep-holes; there had been a diffusion cloud-chamber working, and he had seen that too. He was delighted. Only one discontent clouded his joy. Travel by civilian air-liner was not overmuch to his liking. His preference was for the rigours and the excitement of the ancient *Anson* of the weather flight, in which he was flying as a student whenever occasion offered, an honorary member of the meteorology class of the University of Edinburgh. Such flights were a recurring delight of his last years, taking him to the north-west, over the outer isles, in fine weather and foul.

C. T. R. lived to become a legend: for me he was already legendary nearly forty years ago. The headmaster of my Yorkshire grammar school had been head of the science side at Bradford in the 1890's, and there, for a brief spell, C. T. R. had endeavoured to instruct the young, soon after he had graduated at Cambridge in 1892. In later years, when he had retired from Bridlington, Arthur Thornton reminded the authorities of his former school of a forgotten episode of its history, how for a little while it had numbered among its staff a future Nobel prizeman—and had not known his worth.

Wilson's father died when he was four years old. Thereafter his mother moved to Manchester, and C. T. R., intending to become a doctor, entered Owens College to study biology. Balfour Stewart (an Edinburgh man) was professor of physics at the time. A dozen years previously, or thereby, J. J. Thomson had passed through his class on his way to Cambridge. C. T. R. went on to Cambridge, also to Sidney Sussex College, with an entrance scholarship. Not until then did his interest veer to the physical sciences; but once the decision had been taken, that he should abandon medicine, there was no turning back. By the beginning of 1895 he had already started on what was to prove his major work. It was an unlikely beginning for a fundamental research, yet, after thirty years, it was to fill the physical laboratories of the world with an apparatus which, for a generation, did more to speed the progress of experimental physics than any other agency.

In 1895, Wilson was merely attempting "to imitate in the laboratory" the 'glories' which he had seen on the summit of Ben Nevis in the late summer of the previous year. But he had a sharp eye, and a keen mind, and he had been working for no more than a few months before his interest became engaged in the few drops which reappeared time after time continually, as often as he chose to expand a volume of moist, dust-free, air by more than a 5 : 4 ratio. He seized the significant conclusion that in such circumstances condensation nuclei must be being produced continuously throughout the sample of air. This observation could not have been made at a more opportune time—or in a more suitable place. In December 1895 news of Rontgen's discovery startled the world; towards the end of the following month, in Cambridge, Thomson and McClelland discovered the conductivity imparted to air by the passage of X-rays. Old knowledge concerning the slight 'residual' conductivity of the atmosphere now began to fit into place, and it was with 'delight', but scarcely, one imagines, with surprise, that Wilson found his 'rain-like' condensation enormously increased when he exposed his primitive cloud chamber to the new rays. This was in February 1896. The hypothesis that the conductivity was due to gaseous ionization was firmly established by Thomson and Rutherford during the summer of that year. Thereafter no one doubted that gaseous ions could be fixed in this manner—by condensing water vapour on them, through the process of adiabatic expansion.

Characteristically, Wilson did not himself become involved, at that time, in the excitement of the new investigations into the other properties of X-rays or of the Becquerel radiation. Instead, he carried out a full investigation of the details of the condensation phenomenon and with simple apparatus, but sure insight, a thorough study of the residual ionization in air and other gases. Then, in the early years of the century, he turned to different problems, and an increasing load of advanced teaching came to occupy his time. In 1910 a second phase of interest in the cloud apparatus followed, and early in 1911, for the first time, the tracks of individual α-particles and electrons were seen and photographed. The paths of the α-particles were just as W. H. Bragg had drawn them, five years previously, and the tracks of the electrons "little wisps and threads of clouds". This achievement was widely—and justly—acclaimed but, strangely, the literature of the period provides little evidence that others elsewhere sought to emulate Wilson's success.

The situation was entirely different after the third phase of Wilson's own interest. By 1923 he had finally brought to perfection this most remarkable method of experiment. The photographs of electron tracks with which he illustrated two classic papers published in that year were of such quality—and beauty—that the cloud chamber could no longer be dismissed as an amusing toy. All over the civilized world workers built themselves the necessary equipment. In Cambridge, Blackett and Kapitza; in Paris, Irène Curie and Auger; in Berlin, Bothe and Meitner and Philipp; Skobelzyn in Leningrad; Kikuchi in Tokyo—all within a very few years were operating Wilson cloud chambers with signal success. This was but the beginning of the story, and it is pointless here to continue it. Whoever turns the pages of a physical journal of the past thirty years will see for himself something of what the harvest has been: he will appreciate the abundance of it even more clearly if he turns the pages of "An Atlas of Typical Expansion Chamber Photographs" (1954), with its dedication to "C. T. R. Wilson, whose invention of the cloud chamber made these photographs possible", and its frontispiece reproducing his portrait by James Gunn. There could be no better *Festschrift*.

Wilson gave to physicists in general a sharp tool for research, second to none. By contrast, he gave to very few of them his personal guidance, as director of their individual researches: to Wormell, in the general field of atmospheric electricity (in this notice Wilson's contributions to this field have no more than been hinted); to Powell and Dee and J. G. Wilson in cloud-chamber studies; so the list is almost complete. Too much must not be made of this distinction: whether he be of the select few, or of the many, every physicist who has ever operated a cloud chamber must acknowledge his debt. It cannot be measured in words.

C. T. R. Wilson was born on February 14, 1869. He died on November 15 in the midst of his family. Mrs. Wilson, his son and two daughters survive him.

NORMAN FEATHER

NEWS and VIEWS

British Ceramic Research Association:

Dr. A. T. Green, C.B.E.

DR. A. T. GREEN retires from the directorship of the British Ceramic Research Association on December 31, after thirty-eight years service to the ceramic industry, during which time he has established himself as one of the world's leading ceramists. An old boy of Hanley High School, he joined Dr. Mellor at the British Refractories Research Association after the end of the First World War and quickly became associated with work on refractories for the steel and gas industries, and by his incisive attack on the problems he then encountered he laid the foundation for future developments, the benefits of which are still being reflected in the economics of those industries. He was made assistant director in 1931 and succeeded to the directorship on Dr. Mellor's retirement in 1937. After the Second World War, Dr. Green, who had been made O.B.E. for his contribution to the war effort, was charged with the task of uniting the British Refractories Research Association and the British Pottery Research Association to form the British Ceramic Research Association, and he took up the directorship in 1947. The Association's main laboratories in Queens Road, Penkhull, opened in 1951 by the Duke of Edinburgh, were planned under Dr. Green's direction, and the steady output of research papers—more than 400 have been published since 1948—is a tribute to the inspiration with which he has led his team of research workers. Dr. Green has been able to see, before his retirement, the completion of another laboratory block—to be named the Mellor-Green Laboratories—which is to serve the structural clay products branch of the ceramic industry. Dr. Green was made C.B.E. in 1957, and was awarded the degree of D.Sc. *honoris causa* by the University of Leeds in 1949. He is an honorary member of the Institute of Gas Engineers and of the British Ceramic Society, the latter he has served as honorary general secretary for the past twelve years. He was one of the founders of the Institute of Ceramics and was its first president.

Dr. N. F. Astbury

DR. N. F. ASTBURY, who has been deputy director since 1957, will succeed Dr. Green. Dr. Astbury was a scholar of St. John's College, Cambridge, where he obtained first-class honours in both parts of the Natural Sciences Tripos. After leaving Cambridge, Dr. Astbury was for ten years on the staff of the National Physical Laboratory, and at the outbreak of war went to the Anti-Submarine Experimental Establishment. In 1945, he entered industry to become director of research of the firm of Joseph Sankey and Son, Ltd., and then director of research to the Guest Keen Nettlefold Group of Companies, of which Sankeys is a member firm. During this time Dr. Astbury planned the central research laboratory for the group, which has now been established in Wolverhampton for ten years. Since 1949 Dr. Astbury has held two professorships—one, the chair of applied physics in the University of New South Wales and the other in the University of Khartoum, where he was also dean of the Faculty of Science. For a short time before joining the British Ceramic Research Association he was at the Royal Aircraft Establishment, Farnborough. Dr. Astbury was awarded his Sc.D. by the University of Cambridge in 1954. He serves on the Education and Membership Committee of the Institute of Physics and on the Advisory Board of the *Journal of Scientific Instruments* and the *British Journal of Applied Physics*, and he is also a member of the Board of Studies of the National Council for Technological Awards.

Deputy Director of the National Physical Laboratory Dr G Macfarlane

Dr George Macfarlane, a deputy chief scientific officer at the Royal Radar Establishment, Malvern, has been appointed deputy director of the National Physical Laboratory He succeeds Dr Edward Lee, who has occupied the post since March 1958 (see *Nature*, 181, 600 , 1958), and who now becomes director of the Stations and Industry Divisions at the headquarters of the Department of Scientific and Industrial Research

Dr Macfarlane, who is forty-three, graduated with first-class honours in electrical engineering at the University of Glasgow in 1937, and went on to do two years postgraduate research at Dresden, where he gained the Dr Ing degree in 1939 He joined the Telecommunications Research Establishment (now incorporated in the Royal Radar Establishment) in 1939 Throughout the war years he concentrated on mathematical problems in radar and microwave physics In 1945, he became head of the Mathematical Group, and a year later took charge of the Theoretical Physics Division Since 1953 he has been carrying out individual research in the Physics Department of the Establishment

European Organization for Nuclear Research, Cern

In the fourteenth session of the Cern Council which was held in Geneva on December 2 it was proposed that international co-operation should be developed in the field of high-energy accelerators such as those constructed at the European Centre for Nuclear Research in Geneva The contributions of the Member States have undergone some modification as a result of the accession of Austria to Cern and of changes in the national incomes

Country	1960-62 (%)	1957-59 (%)
Austria	1 93	—
Belgium	4 15	4 89
Denmark	1 99	2 23
France	21 22	22 26
German Federal Republic	19 52	18 27
Greece	1 17	1·08
Italy	10 09	10 61
Netherlands	3 85	3 78
Norway	1 61	1 72
Sweden	4 23	4 85
Switzerland	3 29	3 48
United Kingdom	25 00	25 00
Yugoslavia	1 95	1 83
	100	100

The Council approved contributions from the thirteen member States totalling 65,000,000 Swiss francs for 1960 This compares with a budget of 55,000,000 Swiss francs for 1959 Of the 1960 expenditure, 38,500,000 Swiss francs are earmarked for capital expenses, of which 15,000,000 Swiss francs are for new buildings and general site facilities, and 18,000,000 Swiss francs for auxiliary experimental equipment The remaining 26,500,000 Swiss francs will cover general staff and operating expenditure

The following appointments were announced F de Rose (France) and Prof W Heisenberg (Germany) and J Willems (Belgium) were re-elected respectively president and vice-presidents of the Council J H Bannier (Netherlands) was re-elected chairman of the Finance Committee Prof F Perrin (France) takes the place of Prof H Alfvén (Sweden) on the Scientific Policy Committee

Reactor Project at Halden

The second fuel charge for the Organization for European Economic Co-operation Boiling Heavy Water Reactor Project at Halden, Norway, has been ordered by the Norwegian Institutt for Atomenergi from A B Atomenergi of Sweden The order is worth approximately 500,000 dollars The Halden reactor, which is one of the two experimental reactors in the current programme of the Organization's European Nuclear Energy Agency, has been in operation at zero power since last June using a fuel charge of natural uranium metal With this charge, to which it is intended to add a certain number of slightly enriched uranium 'spikes', a maximum power of approximately 5 MW is expected The second fuel charge will consist of approximately 1,500 kgm of 1 5 per cent enriched uranium oxide, made up into 100 7-element assemblies of zircalloy-clad rods This charge is expected to enable powers up to 20 MW to be obtained Delivery of the second charge will be in March 1961, and will include eight extra fuel assemblies, without uranium, for experimental use in the reactor core

Mental Health Problems in Old Age

A new report issued by the World Health Organization (Technical Report Series, No 171. Geneva W H O , London H M Stationery Office *3s 6d*) deals with some of the psychological and social problems posed by the ageing of populations It is the work of a small expert committee which met in Geneva last year to consider the broad psychiatric implications of present population trends In its report, the committee stresses particularly the need for integrated mental health services for the aged which would provide guidance as well as medical care Emphasis is also placed on the need for fundamental research on the psychological assets and disabilities of older people Although this report deals principally with the strictly psychiatric aspects of old age, it deserves careful study by all concerned with the biology of ageing and the care and management of the elderly

Friends of the Lake District

The annual report of the Friends of the Lake District reviews the work of the association since it was founded twenty-five years ago So long ago as 1936 an agreement was reached with the Forestry Commission not to acquire for afforestation any land within the central 300 square miles of the Lake District In 1937 the first proposals for making the Lake District into a national park were put forward, while, in 1937, the association persuaded the Westmorland and District Electricity Co to modify its plans about overhead electricity lines and to put them underground By 1938 membership of the society had reached 2,700 In the same year, a road policy for the Lake District was produced, the society supporting a case against the making-up as motor roads of the remoter mountain passes and urging restraint against the up-grading of Lake District roads generally At about this time measures were first taken to protect the rarer birds which nest in the high fells This work has continued over the years with beneficial effects The society has also taken vigorous action to prevent the silting and discoloration of Ullswater by effluent from the Glenridding lead mine Other matters in this interesting report include accounts of the measures taken to mitigate the effects of war training areas, control of war-time factories, and the building of reservoirs by local authorities The report (Friends of the Lake District 1934–1959 Retrospect and Annual Report, June 1959 Pp 30) may be obtained from the Secretary, 14 Princes Street, Ulverston, Lancs

Freshwater Biological Association

THE now familiar style of the yearly report of the Freshwater Biological Association should be taken as a model of the way in which reports of scientific associations could be presented (Freshwater Biological Association Twenty-seventh Annual Report for the year ended March 31, 1959 Pp 81 (Ambleside Freshwater Biological Association, 1959) 4*s*) Although brief, it gives details of the administrative work of the Association during the year, a statement of its finances, a description of the staffing position, as well as a clear account of the scientific work carried out by the staff during the year supported by a list of all papers submitted by them to learned societies and journals The presentation should be of particular value to lay members of water boards throughout the country Among interesting scientific work was that by Dr Talling on the photosynthetic behaviour of plankton algae, considered in relation to the problems of primary production in lakes Particular attention has been given to the variation of photosynthesis rate with depth, a fundamental relation in calculations of photosynthetic productivity below unit area In the course of work by Dr Willoughby on the distribution of the lower saprophytic fungi (Chytridiales and Blastocladiales) of Esthwaite water, a species of *Blastocladiella* has appeared repeatedly in baitings from the marginal zone The group Blastocladiales is one which has excited a great deal of interest especially in America, but no member of either of the two most important genera, *Allomyces* and *Blastocladiella,* had ever been recorded before in Britain, and no *Blastocladiella* had been reported from Europe The species found in Esthwaite occurred on all three types of bait used, cellulose, chitin and keratin, and its ability to grow on all three has been verified in cultures grown from a single spore Unlike *B emersonii* Cantino, it does not respond to treatment with bicarbonate by producing resting spores The report is available from the Secretary, The Ferry House, Far Sawrey, Ambleside, Westmorland

The Institution of Mining Engineers

IT is announced that Mr R G Baker has been elected president for the year 1960–61 in succession to Mr T A Rogers Ir A Hellemans (director, Staatsmijnen in Limburg) and Dr J Taylor have been elected honorary members of the Institution The tenth award of the Douglas Hay Medal, instituted in 1950 in memory of the late Prof D Hay, past-president, has been made to Mr A E Crook in recognition of his valuable contributions to engineering practice in mining with special reference to haulage and winding and for his papers on these subjects in the *Transactions* The Maskell Peace Scholarship of £70 for 1959, the tenth since the Institution accepted the trusteeship of the fund from the Mining Association of Great Britain, has been awarded by the North of England Institute of Mining and Mechanical Engineers to Mr P Hutchinson, a student at the Department of Mining Engineering, King's College, University of Durham

Trevelyan Scholarships

THE first awards of these scholarships were made in 1958 and the second awards have now been made by the Trust The scheme is sponsored by the following companies Arthur Guinness Son and Co , Ltd , Associated Electrical Industries, Ltd , Courtaulds, Ltd , English Electric Co , Ltd , Guest Keen and Nettlefolds, Ltd , Imperial Tobacco Co , Ltd , John Summers and Sons, Ltd , Peninsular and Oriental Steam Navigation Co , Rolls-Royce, Ltd , Steel Company of Wales, Ltd , Stewarts and Lloyds, Ltd , and the United Steel Companies, Ltd Sufficient funds have been subscribed to permit the award each year of not less than 34 three-year scholarships of £450 a year over a period of five years It was arranged that all applications would first be considered at either Oxford or Cambridge, according to the applicants' first choice, the University panels agreeing upon 'short lists' of candidates for final interview by a selection committee For the second selection 198 applications were accepted, and from these a short list of 58 applicants were interviewed In 1958, 123 applications were accepted and 54 applicants were interviewed The selection committee restricted the awards to 23 in number, of which 12 are tenable at Oxford and 11 at Cambridge In 1958, 19 awards were made 10 at Oxford and 9 at Cambridge

Announcements

COMMENCING January 9, a course of twelve lectures and appropriate practical work on micro- and semimicrochemical methods will be held on Saturday mornings at the Norwood Technical College, London, S E 27 This course has been arranged for teachers, industrial and research chemists, and is designed to survey the principal branches of chemistry in which small-scale methods have been successfully applied Further information can be obtained from the secretary of the College

THE Bradford Institute of Technology has announced that it is holding a symposium on "Recent Developments in Textile Chemistry" and also a short course in "New Techniques in High Polymer Chemistry" The symposium is to be held on February 13 in conjunction with the Bradford Chemical Society and the Yorkshire Council for Further Education The course is to take place during February 26–27 Both are to be held at the Bradford Institute of Technology Further information can be obtained from the Registrar, Institute of Technology, Bradford 7

THE Association of Agriculture has announced that a series of eight evening lectures, the third in its kind to be organized in collaboration with the Extra-Mural Department of the University of London, will be held during January 20–March 9, 1960 The series, "The Land of Britain, is it used to the Best Agricultural Advantage ?", will take place at the London School of Hygiene and Tropical Medicine, Keppel St , London, W C 1 Further information can be obtained from the General Secretary, The Association of Agriculture, 53 Victoria St , London, S W 1

ERRATUM The authors of the communication entitled "Mineral Uptake and Retention in Cottongrass (*Eriophorum vaginatum* L)" published in *Nature* of August 8, p 467, state that the ordinate of Fig 1 was incorrectly printed by them , for "m eq " read "gm "

THE BRITISH COTTON INDUSTRY RESEARCH ASSOCIATION

OPEN DAYS AT THE SHIRLEY INSTITUTE

THE fortieth annual general meeting of the British Cotton Industry Research Association was held at the Shirley Institute on October 22, with the chairman of the Association, Mr N G McCulloch, presiding In his address Mr McCulloch said that he wished to reiterate a view that he had many times expressed, that there was an urgent need in the Lancashire textile industry for a much more concentrated and sustained study of the subject of organization and management than had so far been attempted The Shirley Institute was no stranger to this field of work and had made a number of worthy contributions, but the effort needed intensifying and widening Mr McCulloch also referred to the working party which had been set up to consider the problems involved in the proposed fusion of the Institute with the British Rayon Research Association, and emphasized the importance of this latest move towards rationalizing co-operative research for the Lancashire textile industry

Mr J Lindley, honorary treasurer, in reviewing the statement of accounts for the year, was particularly concerned to emphasize the need for adequate reserves, since expenditure on research could not be turned either off or on like a tap He pointed out that the general reserves at present were in fact only sufficient to pay the Association's outgoings for rather less than nine months

At the end of the meeting, Mr McCulloch announced his forthcoming resignation and tributes were paid both by Mr Lindley and from the floor of the meeting to his great contribution as chairman for the past ten years

Dr D W Hill, director of research, then presented his report on the year's work and stressed the consideration which had been given during the year to the need for a research association to follow up its research work with all possible steps to ensure application in mills and works This was a particular concern of the Institute during the industry's difficult times, and it was reflected, for example, by an increase of 14 per cent in technical inquiries received by the Institute during the preceding year There was also a need to keep abreast of industrial advances in foreign countries, to which end four teams had been sent to the Continent to visit Holland, Italy, France and Western Germany and to report their experiences to members

In selecting a few research and development topics for special comment, Dr Hill mentioned the continuing work for spinners on control of regularity of their intermediate products, and referred to the success of the cop sorting device for condenser spinners A new programme of work was now starting on winding and beaming, with particular emphasis on the variations in the density of various wound packages Results of interest to both spinners and weavers should follow the introduction of a new technique involving the use of a radioactive isotope within the package The work on sizing continued and attention had been paid to, and a device developed for, reducing the hairiness of yarns, particularly those of synthetic fibres Work on the dry-feed attachment of the automatic size box had reached the point of initiating mill trials It was impossible, with the limited resources available, to do simultaneous research on all the widely diverse problems of the industry, and it had been decided to devote attention at intervals to the smaller and more specialized sections At the moment, for example, a fundamental study of the operation of a terry-towel loom was being started

On the chemical side, Dr Hill directed particular attention to past history of work at the Institute on bleaching processes, work which had been recently brought up to date by a thorough examination of the mechanism of sodium chlorite as a bleaching agent, which had also produced very valuable technological results Also for finishers, Dr Hill reported that a long-term physical study of the action of the raising machine had resulted in the introduction of a new kind of instrumentation in this process which should be of great technical benefit

As in previous years, the Institute laboratories were open for inspection for two days, when all members of staff were available for consultation

Spinners were particularly interested in an automatic nep counter, so far only used for research purposes, in which a photoelectric method is used for detecting neps, followed by an electronic counter A new version of the Shirley opener was also shown, as was a recent further improvement to the pressure-point system

In the Weaving Department a large exhibit attracted the attention of members to the widely varied services the Institute could offer them, while another exhibit analysed the major causes of warp breaks during weaving A stretch regulator, the Shirley loom and the new device for reducing hairiness were also operating Most interest in this section, however, was raised by the exhibit showing the range of, and methods used in the investigation being carried out on yarn clearing

Finishers were given working demonstrations of the flash steamer now commercially available and of the new raising action indicator A highly important new programme is that on washing efficiency, with the high cost of water and the expense of effluent disposal becoming increasingly serious Preliminary results already suggest that there will be considerable gains from working in this field

Fundamental work on the mechanism of the burning of cellulose has started and there were demonstrations both of the production of inflammable tars as intermediate products, and also of the behaviour of existing flame-proofing agents The use of infra-red absorption analysis for identification of finishes and contaminants was interesting both fundamentally and as an aid to the technologists

The Institute continues its fundamental investigation of the effect on yarn and fabric properties of blending natural and synthetic fibres, and a general display showed the extent to which it is now possible to forecast many of these properties from a previous knowledge of fibre properties

Old and new instruments were in evidence both for research and control purposes As usual, there was a stand showing the instruments being handled by Shirley Developments, Ltd., which, as a result of rapid growth, now shows in its catalogue 30 instruments and 30 mechanical devices.

New instruments for research purposes included a new photomicrographic apparatus designed and made at the Institute, and also a polarizing lustre meter with which it is hoped to interpret how the eye judges lustre.

It was encouraging that a large proportion of the visitors on the open days came with the definite object in mind of seeing how the Institute's work made an impact on their own mill or works.

AGRICULTURAL INSTITUTE OF THE REPUBLIC OF IRELAND

DIVISION OF PLANT SCIENCES AND CROP HUSBANDRY

THE establishment, under the Agricultural (An Foras Talúntais) Act, 1958, of the Agricultural Institute of the Republic of Ireland, An Foras Talúntais, was announced in *Nature*, July 4, 1959. The Institute now announces major developments in the organization of the Division of Plant Sciences and Crop Husbandry. This will provide a wide coverage in the plant sciences field, catering for research in plant pathology, entomology (including nematology), plant breeding, plant protection, plant quality, weed control, and other general aspects of crop husbandry.

Mr. B. Crombie, at present in charge of the Plant Breeding Station of Cómhlucht Siúicre Éireann, Teo. (Irish Sugar Company), at Thurles, Co. Tipperary, has been appointed chief of this Division. Mr. Crombie, a native of Offaly, gained his B.Agr.Sc. degree with honours at the National University of Ireland in 1934 and was awarded a postgraduate scholarship. In 1937 he gained his M.Sc. degree for a thesis on "The Influence of Various Factors on the Time of Ripening of Wheat Varieties". While working under Prof. M. Caffrey, University College, Dublin, Mr. Crombie was responsible for the breeding of the well-known Glasnevin strains of perennial ryegrass and cocksfoot. He had been responsible for the organization of seed-breeding research and developments with Cómhlucht Siúicre Éireann, Teo., giving to the industry sugar-beet seeds of top quality. Mr. Crombie has published papers dealing with his research work in a number of scientific journals. He comes to his new post with a high reputation not only in plant breeding but also in plant science and crop-husbandry work in general.

By mutual agreement between the Council of An Foras Talúntais and the Industrial Research Committee of the Institute for Industrial Research and Standards, the facilities and equipment of the Cereals Laboratory at the latter Institute have been made available to An Foras Talúntais. This laboratory will devote special attention to the question of baking quality in wheat in relation to soil, manurial, climatic, varietal and cultural conditions, while in addition undertaking research on quality in other cereals. The general supervision of this laboratory for An Foras Talúntais will be in the hands of the director of the Institute for Industrial Research and Standards, Mr. D. T. Flood. Mr. P. A. Spillane has been appointed a senior research officer on the staff of An Foras Talúntais and will be head of the laboratory. Other appointments to this Unit are those of Miss H. McGovern as research officer and Misses K. McGrath and E. Cooper as technicians. Mr. Spillane graduated from University College, Dublin, with honours in physics and chemistry in 1936. He has a wide experience of research and general operational work in the flour-milling industry and is the author of a number of scientific papers dealing with this work.

It has been agreed in principle between the Board of Cómhlucht Siúicre Éireann, Teo., and the Council of An Foras Talúntais that the sugar-beet breeding research facilities at Thurles and the Nematology Laboratory at Carlow of the Irish Sugar Company will be integrated with An Foras Talúntais. These centres have already been placed under the scientific direction of An Foras Talúntais pending the conclusion of arrangements by the staffs of the organizations concerned. This arrangement places at the disposal of the Agricultural Institute the scientific staff and extensive offices, laboratory and greenhouse facilities and equipment which have been developed at these centres over a number of years. While the sugar-beet seed research programme will be continued and expanded at Thurles by An Foras Talúntais on behalf of Cómhlucht Siúicre Éireann, Teo., this centre will also act as headquarters of the Division, with the resulting development of research services in general plant science work apart from those needed for sugar-beet research.

The nematology laboratory at Carlow which provides well-developed facilities for this sphere of research will also be used in the general research programme of the Institute. Dr. J. J. Duggan has been appointed senior research officer in charge of the Nematology Unit of the Institute now located at University College, Dublin. Dr. Duggan is well known for his research work in nematology on which he has published a number of scientific papers, and the Unit at Carlow is now under his scientific direction.

A Plant Pathology Unit has been established. Dr. J. B. Loughnane, Department of Plant Pathology, University College, Dublin, is acting as adviser for this aspect of the activities of the Institute. Mr. P. Cunningham and Mr. C. Comerford are now working under Dr. Loughnane in the Plant Pathology Unit, while Mr. T. E. Mulligan, previously on the staff of the Rothamsted Experimental Station, joined the staff of the Unit on October 1. Associated Seed Growers, Ltd., have generously offered a grant for the investigation of the diseases of a number of crops such as kale and mangels. This offer has been accepted by the Council of the Institute and investigations are already under way.

Arrangements are also being completed for placing an Applied Plant Genetics Research Unit at the Kells Ingram Farm of the University of Dublin, working under the general direction of Mr. G. W. P. Dawson, head of the new Department of Genetics, Trinity College, Dublin. This Unit will deal with some of the more practical aspects of plant genetics. Mr. V. Connolly has been appointed research officer in this Division. Arrangements are proceeding with the organization of the other departments of the Division, and it is hoped to have a full research programme under way during the coming year.

ELECTROPHORESIS OF HUMAN GASTRIC JUICE

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ANALYSIS of the macromolecular components of gastric juice has hitherto given varying results not readily comparable[1-5]. This is in all likelihood due to defective control of autodigestion. The proteolytic effect of the pepsin is so rapid at the low hydrogen ion concentration generally prevailing in normal gastric juice that it is not sufficient to neutralize the juice immediately after aspiration. For that reason, we attempted to neutralize the gastric juice already in the stomach by introducing sodium phosphate buffer.

The gastric juice was collected as a fasting secretion or after insulin stimulation. A suction device prevented the admixture of saliva. Samples contaminated with blood or bile were discarded. The juice collected was cooled immediately on ice and treated continuously in the cold. Visible mucus was eliminated by centrifugation or filtration through glass wool. The juice was concentrated by ultrafiltration through collodion membrane. Paper electrophoresis was performed according to Glass *et al.*[1] in borate buffer at a *p*H of 9·0.

Gastric juice which had been neutralized in the stomach with sodium phosphate buffer of varying *p*H and ionic strength 0·2 was compared with further samples from the same individual, one neutralized immediately after aspiration and another not neutralized. In addition, juice that had been neutralized in the stomach was compared with portions of the same sample which after neutralization had been acidified with 0·1 *N* hydrochloric acid to varying *p*H levels at different temperatures and for varying periods and then again neutralized.

Three main components were found to stain with amido black in 20 human gastric juice samples neutralized in the stomach (Fig. 1). The most rapidly

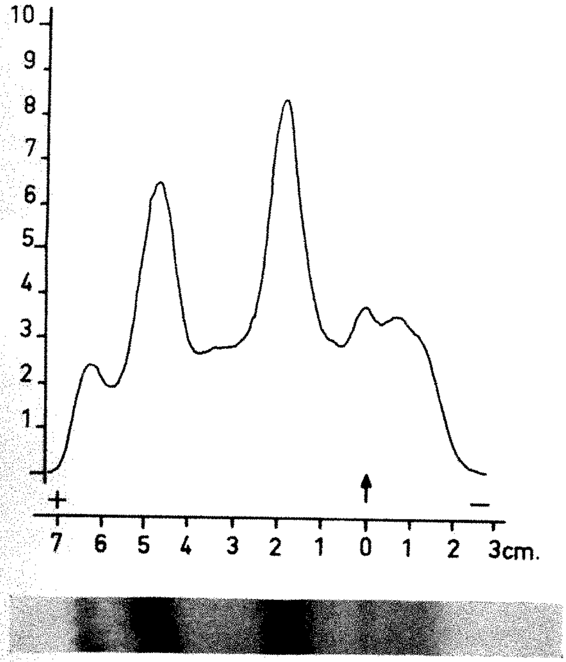

Fig. 1. Paper electropherogram of normal gastric juice neutralized in the stomach with sodium phosphate buffer to *p*H 7·2. Amido black stain

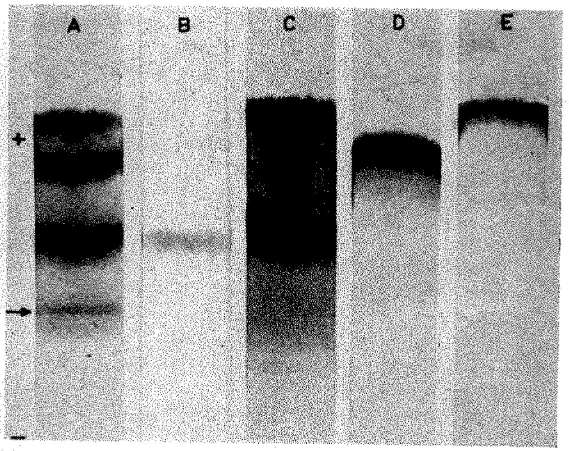

Fig. 2. Electropherograms. *A* and *B*, gastric juice neutralized in the stomach, stained with amido black and periodic acid–Schiff respectively; *C*, same juice aspirated after neutralization in the stomach and acidified with 0·1 *N* hydrochloric acid for 5 min. at 24° C. (*p*H 1–2); *D*, human serum albumin; *E*, crystalline pepsin

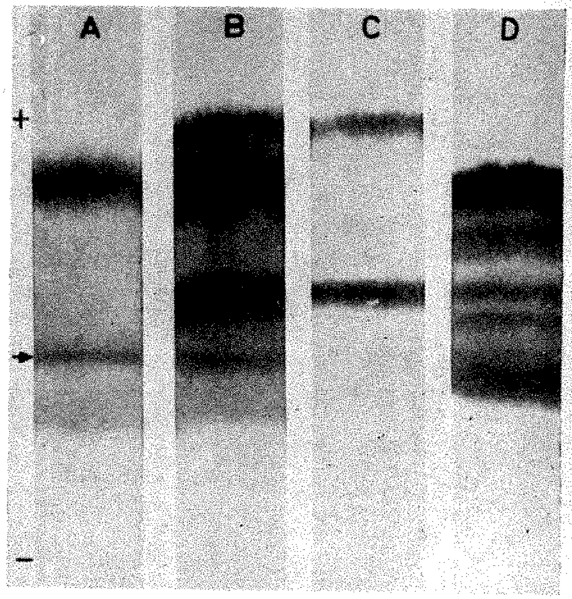

Fig. 3. Electropherograms. Amido black stain. *A*, fasting secretion, *p*H 6. The pepsin band is missing; *B*, gastric juice from the same individual after insulin stimulation, neutralized in the stomach to *p*H 7·2; *C*, juice from the same individual, not neutralized, *p*H 1–2—the albumin is missing; *D*, serum pattern, borate buffer *p*H 9·0

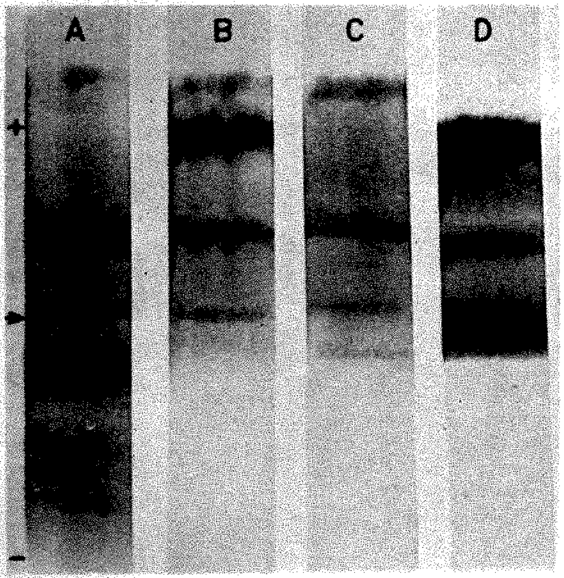

Fig. 4. Electropherograms. Amido black stain. *A*, fasting secretion, not neutralized, pH 2–3; *B*, gastric juice from same individual, neutralized in the stomach to pH 7·2; *C*, same juice aspirated after neutralization in the stomach and acidified with 0·1 *N* hydrochloric acid for 2 min. at 24° C. (pH 1–2)—disappearance of the albumin band; *D*, serum pattern, borate buffer pH 9·0

anodically migrating component has the same mobility as crystalline pepsin (Fig. 2*E*) and has earlier been shown to be a carrier of peptic activity[1]. It is not present in gastric juice from achylia patients (Fig. 5*A*) or in non-acid fasting secretion (Fig. 3*A*); it is occasionally absent in juice which has been neutralized in the stomach to pH 8·0, and is in any event less readily stained than when the juice is neutralized to a pH of 7·2.

The mobility of the second component corresponds to that of pure serum albumin (Fig. 2*D*). This fraction is invariably present also in gastric juice from achylia patients (Fig. 5*A*), while it is absent or found in only small amounts in acid juice not neutralized in the stomach (Figs. 3*C*, 4*A*) and in juice neutralized in the stomach and afterwards acidified (Figs. 2*C*, 4*C*). It persists after acidification of achylia juice to pH 1–2. Gel diffusion analysis according to Ouchterlony[6] exhibited a heavy immunoprecipitate against anti-albumin serum. It is of interest that even normal human gastric juice contains a protein component which seems to be identical with serum albumin, especially in view of recent studies which have shown a leakage of large amounts of albumin into the stomach in so-called idiopathic hypoproteinæmia[2,7].

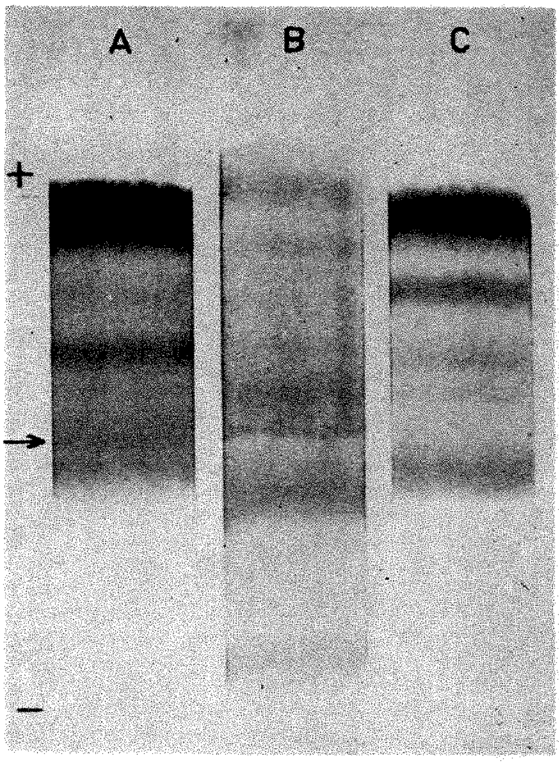

Fig. 5. *A*, Achylia gastric juice; *B*, same juice incubated at 37° C. with crystalline pepsin at pH 1–2 for about 5 min.; *C*, serum pattern, borate buffer pH 9·0

The third component shows a high carbohydrate content with periodic acid–Schiff staining and may, accordingly, represent a mucoprotein complex (Fig. 2*B*).

Acid gastric juice not neutralized in the stomach contains from 2 (Fig. 3*C*) to 8 components, some of which are strongly basic and appear on the cathodic side of the paper strip (Fig. 4*A*). A similar electrophoretic pattern is found in achylia gastric juice incubated with pepsin at a low pH (Fig. 5*B*). Our investigation would indicate that the majority of the many fractions usually found in acid gastric juice, not neutralized in the stomach before aspiration, are breakdown products.

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ECOLOGY OF ACRANIATE LARVÆ

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AND

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LITTLE is known of the habits of acraniate larvæ; the evidence available is conflicting. Willey[1] stated that the larvæ of *Branchiostoma lanceolatum* (Pallas) were entirely planktonic until metamorphosis; van Wijhe[2] suggested that they lived chiefly upon the sea bottom; Webb[3] found that the larvæ of *B. nigeriense* Webb lived part of their life upon the sea bottom, and part in the upper water. It is, therefore, not certain whether the typical acraniate larva spends its life on or near the sea bottom, in the surface layers, or a part in either situation. Moreover, it seems that there may be two different types of larva in the group, each with its own ecology: the 'amphioxides' larva, living for a long period in the plankton and growing to a relatively large size, and the 'amphioxus' type of larva which is smaller, and living partially on the bottom. The 'amphioxides' larva appears to be characteristic of the Epigonichthyidae, the 'amphioxus', of the Branchiostomidae[4]. The present account records observations upon four species of acraniate larvæ found in the Indo-Malayan plankton, which give some indication of the habits of both types of larva, and which show that the 'amphioxides' larva is also found in the Branchiostomidae. These larvæ were taken during a plankton survey made by the Singapore Regional Fisheries Research Station; they occurred at 3 stations only (namely, Permanent Station No. 5; Station *C*3/17, and Station *C*6/18).

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Station No. 5. (Singapore Strait: 1° 14′ N., 103° 55′ E.) At this station diurnal vertical migration was investigated by taking 16 horizontal samples at four depths (surface, 27, 55 and 82 m.) throughout a year. At the last depth, the net was only 6 in. above the bottom. The samples were taken in full daylight, just before sunset, just after sunset and in darkness.

Acraniate larvæ were found regularly in these samples from the latter half of October up to January. They were at various stages in development; some individuals were metamorphosing. These larvæ had 10–21 gill slits and were 3·6–5·2 mm. long. A single juvenile 17·5 mm. long was also found. All belonged to *Branchiostoma belcheri* Gray. Webb[5] has recorded the adult from this area. Analysis of the samples showed that, while numbers of the larvæ were small, their behaviour was consistent. Fig. 1 illustrates the way in which the larvæ stay on, near, or possibly within the sea-bed during the day, and move upward at dusk, showing the largest concentration at the surface for a short period after sunset; afterwards they disperse. As a rule, the greatest numbers of larvæ were taken at night. Bedford[6] found larvæ in Singapore Strait at night only.

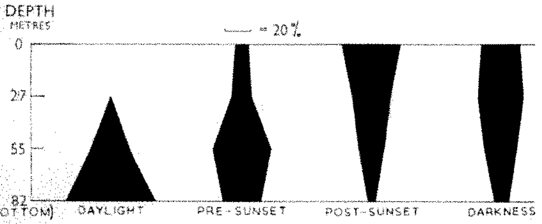

Fig. 1. Percentage vertical distribution of *Branchiostoma belcheri* larvæ

Webb[3] recorded vertical movements of *B. nigeriense* larvæ, and demonstrated experimentally that they reacted to temperature and salinity variations, these responses determining their position in the water layers. At Station No. 5, temperature and salinity variations with depth were negligible, and the larvæ were not being stimulated to move from unfavourable to favourable surroundings as Webb found with *B. nigeriense*. The possibility of passive swirling by up-currents can be discounted. The conclusion is that *B. belcheri* larvæ migrate actively upward through the water, reaching the surface as darkness falls. Twilight at Singapore is short, the two series of samples taken just before and just after sunset being only about 75 min. apart. From this, and the distances involved, it is estimated that the larvæ are capable of moving through a vertical distance of 35 m. in approximately 90 min., equivalent to 6·5 mm./sec.

The actuating stimulus for the migration is not known, but in view of Chin's[7] observations on larvæ of *B. belcheri*, it would appear to be light intensity.

The possibility that the migration is one where the larvæ move into areas richer in food is not suggested by examination of the gut contents. Of the guts examined, 5 (8 per cent) had no discernible food present; the remainder contained food particles in a mucous rope. The following diatom genera were identified: *Coscinodiscus*; *Pleurosigma*; *Nitzschia*; *Melosira*; *Achnanthus*; *Navicula*; *Rhizosolenia* and (?) *Cocconeis*. There were also silico-flagellate skeletons, what are probably small echinoderm spine fragments, and finely divided debris, both organic and inorganic. Most of the diatom genera are normally bottom dwelling; these formed the bulk of the food. No doubt frustules of the two genera *Coscinodiscus* and *Rhizosolenia* would form a natural part of the bottom detritus at this depth.

It seems then that the larvæ feed only when on the bottom; such an intermittent pattern of feeding has been inferred for larvæ of *B. lanceolatum*[8], the cycle taking at least 9 hr. to complete.

A study of the water movements of the area has shown that the diurnal migration would have the effect of distributing the species; it was Goldschmidt[9] who first suggested that each species of acraniate might possess the two types of larva known in the group, and that one would be distributory and pelagic (the 'amphioxides' larva), the other bottom-living; however, the larva of *B. belcheri* is not of the 'amphioxides' type.

Another result of the vertical movement would be the avoidance of nocturnal bottom-feeding predators, for example, penaeid prawns. Mr. D. N. F. Hall (personal communication) informs us that these animals find their food by 'grubbing around' on the bottom, and, although somewhat selective in their feeding habits, many are omnivorous and quite capable of including the larvæ in their diet. These prawns are sufficiently numerous to comb a large area of the sea-bed at night. No doubt other predators behave similarly.

There are other observations that acraniate larvæ of different species rise to the surface at night. Gibson[10] noted that more than three-quarters of his material had been taken at the surface by night. Recent catches of *B. lanceolatum* larvæ in the North Sea have been made at night and just after sunrise at the surface (Cattley, J. G., personal communication, 1957, and Williamson, M. H., personal communication, 1959). It seems, therefore, that the diurnal vertical migrations of *B. belcheri* larva at Station No. 5 are possibly characteristic of acraniate larvæ in general, the behaviour patterns described by Willey and by Webb for *B. lanceolatum* and *B. nigeriense* being perhaps referable to the special environments of each of the populations studied.

*Station C*3/17 (Malacca Strait: 7° 12′ N., 97° 12′ E.). A single sample was collected at this station between 2100 and 2115 hr. (sunset about 1845 hr.), at a depth of 1·5 m. Total depth was 1,005 m. (550 fathoms), the station being about 50 miles outside the 100-fathom line. Larvæ of two species were found; the majority belonged to *Branchiostoma malayana* Webb, but there were also a few of an 'amphioxides' type. The guts of the *B. malayana* larvæ were generally almost empty, but some larvæ had caught relatively large frustules of *Rhizosolenia* sp., which lay along the peripharyngeal bands and at the top of the branchial chamber More common were chain diatoms (probably *Bellerochea* sp), which were sometimes longer than half the entire branchial chamber One gut contained part of a single small crustacean limb appendage and a doubtful small crustacean antenna , these were not lying along the top of the branchial chamber Both forms of diatoms are normally pelagic, suggesting that these larvæ had been feeding in mid-water, and in any event, the depth of water over which the larvæ were caught does not suggest that they can have been feeding near the bottom From the position of the station, the depth of water and the gut contents of the larvæ, it appears that the 'amphioxus' type of larva of *B malayana* is truly pelagic, and that it does not spend the daylight hours upon the bottom as does the larva of *B belcheri* No metamorphosing individuals were found , the larvæ had 12–18 gill slits Only two adults of this species are known, both collected by one of us from the inter-tidal zone of south-east Singapore[5]

The amphioxides larvæ collected at this station belong to the Branchiostomidae, forming the second record of this type of larva from the family (Fuller[11]) They are of a different species from that discussed by Fuller, and will be described in a subsequent publication

Station C6/18 (800 miles E N E Singapore 6° 18′ 25″ N , 115° 36′ 50″ E) Only 3 acraniates were collected from this station, one a post-metamorphic *B belcheri*, the others amphioxides larvæ, probably belonging to *Amphioxides pelagicus* (Gunther), an entirely pelagic form and almost certainly the larva of *Asymmetron lucayanum* Andrews

Goldschmidt[12] stated that doubt remained because the form of the tail fin in his specimens of *A pelagicus* differed from that of the *Asymmetron* adults , it is interesting that the present larvæ show a tail fin more similar to the adult than did Goldschmidt's specimens

Station C6/18 was situated near a steeply shelving bottom in a depth of 64 m , so that it is not surprising that both pelagic and diurnally bottom-dwelling larvæ were found together

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ENZYMIC ACTIVITIES OF HUMAN SKELETAL MUSCLE MITOCHONDRIA : A TOOL IN CLINICAL METABOLIC RESEARCH

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MITOCHONDRIA are the well-established site of cellular respiration and of those enzymic processes by which the energy liberated in terminal electron transport is conserved in the form of high-energy phosphate, notably adenosine triphosphate In intact mitochondria, respiration and the accompanying phosphorylation are coupled together in an obligatory manner, and this coupling is generally considered to constitute the level at which the metabolic rate of the animal organism as a whole is regulated In spite of the vast amount of experimental work with isolated mitochondria which underlies these concepts, relatively few studies are so far available on mitochondria from skeletal muscle, the largest tissue of the vertebrate body, and none, to our knowledge, on skeletal muscle mitochondria from human beings Considering the relative simplicity with which specimens of human skeletal muscle can be obtained by biopsy, such studies were felt to be of some interest, with potentialities of providing information of both biochemical and clinical significance

In the present work, some enzymic properties of normal human skeletal muscle mitochondria were investigated and compared with those of mitochondria from a choice of patients with elevated basal metabolic rates The following well-known characteristic properties of intact vertebrate mitochondria were considered their capacity to catalyse the aerobic oxidation of various Krebs cycle metabolites and glutamate[1] , to carry out oxidative phosphorylation[1] , to adjust their respiratory rate to the availability of a terminal phosphate acceptor[2], that is, to display so-called respiratory control , and to exhibit adenosine triphosphatase activity induced by 2,4-dinitrophenol[3]

For the present study, three cases of hypermetabolism were selected (1) a case of classical thyrotoxicosis of moderate degree (basal metabolic rate + 50 per cent) , (2) a patient with so-called thyrotoxicosis factitia, that is, a subject deliberately consuming large doses of thyroid hormone (basal metabolic rate + 50–80 per cent) , and (3) a patient with an extremely high basal metabolic rate (basal metabolic rate + 150– + 170 per cent) of unknown origin, with no demonstrable thyroid disorder , a detailed description of this unique case will be published elsewhere

Specimens of skeletal muscle from subjects with no evidence of metabolic disorder ('normal' subjects) were obtained in connexion with surgical interventions, and from the patients with hypermetabolism by biopsy In case 3, two biopsies were made, with an interval of sixteen days The form of anæsthesia, general or local, was shown to be of no significance for the mitochondrial properties studied here.

The mitochondria were isolated according to the well-documented procedure of Chappell and Perry[4], using a homogenizing medium containing 0 1 *M* potassium chloride, 0 05 *M tris*-(hydroxymethyl)-

Table 1. Respiration, Phosphorylation and Adenosine Triphosphatase Activity of Skeletal Muscle Mitochondria from Normal and Hypermetabolic Subjects

Case No.	Muscle	Respiration: µatoms oxygen/20 min./gm. muscle, Without hexokinase-glucose	Respiration: µatoms oxygen/20 min./gm. muscle, With hexokinase-glucose	Respiration: Stimulation by hexokinase-glucose (times)	Phosphorylation: µmol. phosphate per µatoms oxygen	Adenosine triphosphatase activity: µmol. phosphate/20 min./gm. muscle, Without 2,4-dinitrophenol	Adenosine triphosphatase activity: µmol. phosphate/20 min./gm. muscle, With 2,4-dinitrophenol	Adenosine triphosphatase activity: Stimulation by 2,4-dinitrophenol (times)
	Normal subjects							
1	Sartorius	2.1	8.8	4.2	2.9	2.1	12.0	5.7
2	,,	2.4	9.9	4.1	2.7			
3	Pect. major	0.3	4.9	16.3	2.4	4.6	16.8	3.7
4	,,	0.3	3.6	12.0	3.0	4.4	18.0	4.1
5	,,	2.0	9.1	4.6	2.6			
6	Ext. obl. abd.	0.7	6.2	9.0	2.9	4.0	10.9	2.7
7	,,	1.6	6.6	4.1	2.6			
8	,,	1.0	4.1	4.1				
	Hypermetabolic subjects							
1	Sartorius	2.8	6.8	2.4	2.9	4.0	13.5	3.4
2	,,	2.6	3.7	1.4	1.9	6.6	9.0	1.4
3*a*	,,	7.3	8.9	1.2	2.6	9.7	11.2	1.1
3*b*	,,	3.1	4.6	1.5	1.7	11.2	17.7	1.6

For experimental conditions and description of hypermetabolic cases, see text. *a* and *b* refer to two different biopsies made on the same case.

aminomethane buffer, *p*H 7.4, 0.001 *M* sodium adenosine triphosphate, 0.005 *M* magnesium sulphate and 0.001 *M* ethylenediaminetetraacetate ('*tris*-potassium chloride medium'). The conventional sucrose-procedure proved to be unsuitable because of gel-formation during homogenization. The excised muscle-specimens were quickly immersed in ice-chilled *tris*-potassium chloride medium, cut into small pieces and homogenized in 3–4 volumes of *tris*-potassium chloride medium by means of an all-glass Potter–Elvehjem homogenizer. All operations were performed at 0–2° C. The homogenate was diluted with *tris*-potassium chloride medium to contain 1 gm. muscle per 10 ml., and centrifuged in a Model *L* Spinco ultracentrifuge, rotor 30, with 2,500 r.p.m. for 5 min. to remove nuclei and myofibrils. The supernatant was decanted and recentrifuged in the same rotor with 10,000 r.p.m. for 10 min. The resulting sediment, representing the mitochondrial fraction, was resuspended in *tris*-potassium chloride medium and recentrifuged as above. The washing medium was discarded, and the surface of the tightly packed pellet was rinsed several times with 0.25 *M* sucrose in order to remove the last drops of *tris*-potassium chloride medium. The pellet was finally suspended in 0.25 *M* sucrose to contain mitochondria from 1 gram muscle per ml. of suspension.

Respiration was measured by the conventional Warburg method, with air as the gas-phase, and with 0.2 ml. 2 *M* potassium hydroxide in the centre wells. Each manometer-vessel contained mitochondria from 1 gram muscle, 10 µmol. substrate (potassium salt), 50 µmol. potassium phosphate (*p*H 7.5), 3 µmol. disodium adenosine triphosphate, 8 µmol. magnesium chloride, 250 µmol. sucrose, and where indicated, 50 µmol. glucose and an excess of yeast hexokinase, in a final volume of 2 ml. The temperature was 30° C. and the vessels were thermo-equilibrated for 5 min. Phosphate uptake was estimated by the isotope distribution method described by Lindberg and Ernster[5]. The phosphate/oxygen ratio was calculated by dividing the phosphate uptake in µmol. during 25 min. by the 20-min. oxygen-consumption value in microatoms, corrected by extrapolation for the 5-min. period of thermo-equilibration. The test-system for adenosine triphosphatase contained mitochondria from 200 mgm. muscle, 10 µmol. disodium adenosine triphosphate, 10 µmol. *tris*-(hydroxymethyl) aminomethane buffer (*p*H 7.5), 90 µmol. potassium chloride, and 250 µmol. sucrose, in a final volume of 2 ml. 2,4-Dinitrophenol was present, when indicated, in a final concentration of 0.1 m*M*. The samples were incubated in open tubes with gentle shaking at 30° C. for 20 min. After fixation with perchloric acid, inorganic phosphate was estimated by the modified Martin and Doty method[5].

Fig. 1 compares the respiration obtained with various substrates in skeletal muscle mitochondria from a normal and a hypermetabolic (case 3, first biopsy) subject. Both preparations catalysed the oxidation of various Krebs cycle metabolites and of glutamate according to similar patterns. Although the absolute rates of respiration varied to some extent from one preparation to another (Table 1), the relative rates obtained with the various substrates were fairly consistent and independent of the species of skeletal muscle used; moreover, a similar picture was also found with skeletal muscle mitochondria from rat. Pyruvate (in the presence of malate) and α-ketoglutarate were oxidized at relatively high rates, whereas other Krebs cycle metabolites, including pyruvate or malate alone, were oxidized only slowly; the rate of oxidation of glutamate varied between high and medium-high from one preparation to another. Of some interest may be the relatively slow rate at which succinate was oxidized. This finding was in sharp contrast to the case found with mitochondria from other vertebrate tissues, including

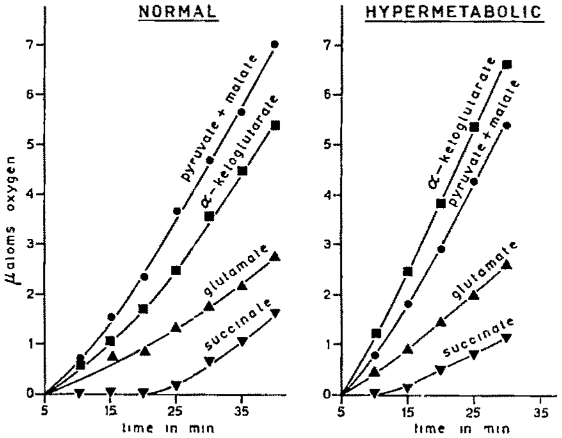

Fig. 1. Respiration of skeletal muscle mitochondria in the presence of various substrates. Muscle specimens (in reference to Table 1): normal subject, case 3; hypermetabolic subject, case 3*a*. For experimental conditions, see text. Hexokinase and glucose were added to all samples

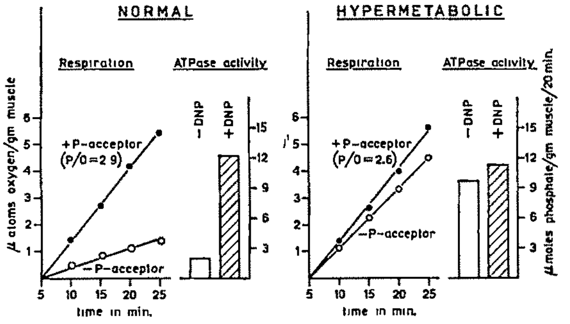

Fig 2 Respiratory control, phosphorylative efficiency and adenosine triphosphatase activity of preparations of human skeletal muscle mitochondria Muscle specimens (in reference to Table 1) normal subject, case 1 , hypermetabolic subject, case 3*b* For experimental conditions, see text Substrate pyruvate + malate Hexokinase and glucose were added to samples marked '+ P-acceptor' DNP=2,4-dinitrophenol

heart muscle sarcosomes Glycerol-1-phosphate, which is oxidized at an extremely high rate in insect flight muscle mitochondria[6], was oxidized only very slowly, if at all, in the present preparations In general, the data presently available give the impression that, in the case of vertebrate skeletal muscle mitochondria, the two α-keto acids are the only Krebs cycle metabolites with a free access to the mitochondrial enzymic sites In none of these respects were there any differences between the mitochondria from the normal and hypermetabolic groups. Furthermore, addition of diphosphopyridine nucleotide resulted in no increase in the respiration (with pyruvate + malate as substrate), indicating that the mitochondria from both the normal and hypermetabolic subjects had an adequate complement of bound diphosphopyridine nucleotide

The capacity to respiratory control was tested according to Lardy and Wellman[2], by measuring the increase in respiratory rate occurring upon the addition of an excess of yeast hexokinase and glucose in the presence of a catalytic amount of adenosine triphosphate Glucose serves in this system as a terminal phosphate acceptor, removing, by way of the hexokinase-reaction, the adenosine triphosphate formed during respiration, and thus continuously regenerating adenosine diphosphate In carefully prepared mitochondria from most vertebrate tissues, respiration is tightly coupled to phosphorylation, and therefore, a continuous supply of adenosine diphosphate is necessary to maintain a maximum level of respiration As seen in Fig 2, the skeletal muscle mitochondria from a normal and a hypermetabolic (case 3, second biopsy) subject revealed a marked difference in this respect In the normal case, the respiration obtained in the absence of a terminal phosphate acceptor was relatively low and was increased to a considerable extent—by more than 300 per cent—by the addition of hexokinase and glucose The hypermetabolic mitochondria, on the other hand, exhibited a nearly maximal rate of respiration even in the absence of a terminal phosphate acceptor, and hexokinase and glucose stimulated it only by about 20 per cent By sharp contrast, both mitochondrial preparations revealed normal phosphorylative efficiencies, the phosphate/oxygen ratios in the presence of hexokinase and glucose being 2 9 in the normal and 2 6 in the hypermetabolic case, as compared with the theoretical maximum of 3 This, it appears that while both preparations were capable of coupling respiration to phosphorylation to a normal extent, this coupling was markedly looser in the hypermetabolic than in the normal mitochondria.

Another means of demonstrating this difference between the two preparations with respect to the tightness of the coupling of respiration to phosphorylation has been to investigate their adenosine triphosphatase activities in the absence and presence of 2,4-dinitrophenol. It is a well-established fact that carefully prepared mitochondria exhibit a very low adenosine triphosphatase activity and that this activity can be greatly stimulated by a concentration of dinitrophenol that uncouples phosphorylation from respiration[3] As shown in Fig 2, the mitochondria from the normal-metabolic subject followed this pattern in exhibiting a relatively low endogenous adenosine triphosphatase activity, which could be stimulated 5 7-fold by 0 1 m*M* dinitrophenol , this value is in good agreement with that reported by Chappell and Perry[4] for pigeon breast muscle mitochondria The mitochondria from the hypermetabolic subject, on the other hand, exhibited a relatively high endogenous adenosine triphosphatase activity, and the stimulatory effect of dinitrophenol was only 1 1-fold It is noteworthy that the endogenous adenosine triphosphatase of the hypermetabolic subject's mitochondria did not require magnesium ions as an activator, in contrast to the adenosine triphosphatase that can be elicited in isolated normal mitochondria by exposure to conditions which cause structural alteration, for example, ageing[3] That the activity of adenosine triphosphatase was truly endogenous and not due to contaminating myosin could be ascertained by showing that it was greatly inhibited, to the extent of 85 per cent, by 3 5 m*M* atebrin As recently shown by Low[7], this compound, in the concentration mentioned, almost completely inhibits the endogenous mitochondrial adenosine triphosphatase but leaves myosin-adenosine triphosphatase unaffected

In Table 1, cumulative data are shown regarding respiratory rate, phosphate/oxygen ratio, respiratory control, and dinitrophenol-stimulability of adenosine triphosphatase, from a number of normal cases and the three hypermetabolic cases previously described Pyruvate + malate was used as substrate throughout these experiments The two groups differed consistently with respect to the extents of respiratory control, the stimulation of respiration by hexokinase and glucose varying between 4 1- and 16 3-fold in the normal, and between 1 2- and 2 4-fold in the hypermetabolic group Significant, though less marked, was the difference in the dinitrophenol-stimulation of the adenosine triphosphatase, which was 2 7- to 5 7-fold in the normal group and 1 1- to 3 4-fold in the hypermetabolic group The phosphate/oxygen ratios were, as an average, somewhat lower in the hypermetabolic than in the normal cases, but, as cases 1 and 3*a* show, virtually normal phosphate/oxygen ratios could definitely be obtained in mitochondria with a markedly low respiratory control Finally, the respiratory rates per gram muscle varied somewhat from one experiment to another, and so did also the maximum (dinitrophenol-stimulated) rates of the adenosine triphosphatase reaction The reasons for these variations, which were equally present in the normal and hypermetabolic cases, are being investigated

The concept that the mitochondrial respiratory control may constitute the biochemical basis of thyroid hormone action was first formulated by

Lardy[8] This effect has often been interpreted as a secondary consequence of a lowered phosphorylative efficiency[9], a deficient complement of bound mitochondrial co-factors, notably diphosphopyridine nucleotide[10], or a swollen mitochondrial structure[11] Yet, Lipmann *et al* [12] were able to demonstrate a normal phosphorylation and no deficiency of diphosphopyridine nucleotide when liver mitochondria from thyrotoxic animals were incubated under appropriate conditions

The present results support the concept that a deficient control of respiration by available phosphate acceptors, paralleled by an increased endogenous adenosine triphosphatase activity, constitutes the primary manifestation of the hypermetabolic state at the mitochondrial level The data seem clearly to eliminate the possibility of these changes being secondary to other alterations of the mitochondrial enzyme organization of the types mentioned above, at least as far as a lowered phosphorylative efficiency and a deficient complement of bound co-factors, such as diphosphopyridine nucleotide and magnesium, are concerned Furthermore, according to preliminary data, these mitochondria reveal no increased tendency to swelling , the fine structure of the mitochondria *in situ* is being investigated by electron microscopy Finally, the results also seem to indicate that this alteration of the mitochondrial function may be present regardless the etiology of the hypermetabolism, and that, as case 3 indicates, a thyroid disorder is no prerequisite of the mitochondrial dysfunction described in the present work

Recently, Remmert and Lehninger[13] reported the isolation from mechanically disrupted mitochondria of a protein factor which, when added to phosphorylating mitochondrial fragments abolished the respiratory control without appreciably affecting the phosphate/oxygen ratio The release of this factor from the mitochondria may, according to these authors, be subject to physiological or endocrine control, determining the state of respiratory control in the cell The possible involvement of Remmert and Lehninger's factor in the present connexions is being investigated

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SEROLOGICAL DISTINCTION OF ADULT AND FŒTAL HUMAN HÆMOGLOBIN

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THE interpretation of serological studies of hæmoglobin is difficult because a preparation of hæmoglobin may contain two or more distinct hæmoglobins as well as other soluble antigenic constituents of the red cell Markowitz, Cartwright and Wintrobe[1] have investigated quantitatively antisera prepared against erythrocuprein Among the anti-hæmoglobin sera used in the present work several contained anti-carbonic anhydrase Boivin and Hartmann[2] found several antigens in the hæmoglobin solutions used in their serological studies , they obtained evidence that two of the antigens in normal adult red cells were hæmoglobins Ruggieri and Marchi[3] have also presented serological evidence of two hæmoglobins in preparations from adult red cells and considered one of them to be fœtal hæmoglobin

In the present work, serological differences between hæmoglobin from adult human blood and from umbilical-cord blood have been demonstrated by Oakley and Fulthorpe's agar diffusion technique[4] Antisera were obtained from rabbits which received intravenous injections of adult human hæmoglobin without adjuvant The antiserum used for the experiments shown in Figs 1 and 2 and Table 1 gave a red precipitate containing 5 08 mgm protein which included 0 47 mgm hæmoglobin when 1 ml. antiserum was mixed with homologous antigen in slight antiserum excess of the optimal proportions[5]

In agar diffusion experiments, antiserum was mixed with an equal volume of 2 per cent agar at 50° C , the mixture was put in a tube of 6 5 mm calibre to make a column 18 mm long and allowed to solidify 1 per cent agar was added to make a column 17 mm long and, after this had solidified, 0 3 ml of 0 16 per cent hæmoglobin was added Agar and antigens

Table 1

Hæmoglobin antigen number	Distance in mm between lower boundaries of two precipitation bands in agar after 11 days	Optimal proportions titrations	
		Optimal ratio with 1 per cent antigen	Flocculation time of optimal mixture with antiserum diluted 1 in 25
Adult 1	—	1 15	4 min 45 sec
Cord blood 2	3 7	1 22	17 min 30 sec
Cord blood 3	2 9	1 23	13 min 30 sec
Cord blood 4	2 0	1 21	12 min 30 sec
Cord blood 5	1 2	1 19	8 min 15 sec

were dissolved in 0 85 per cent sodium chloride , 1 in 10,000 merthiolate was present in each reagent and the *p*H of the antigens and of the 1 per cent agar was adjusted to about 7 8 by addition of sodium bicarbonate

Fig 1 shows the reaction observed after eleven days at room temperature In each tube antigen and antibody have diffused into the middle layer, which consists of agar only, and a band (really a disk) or bands of precipitate have formed in this layer Antigen 1, which was hæmoglobin prepared from adult human blood, showed one band of red precipitate Antigens 2, 3, 4 and 5 were hæmoglobin obtained from the umbilical-cord blood of four individual babies, all showed two bands of red precipitate after two days The number of bands of precipitate formed in agar diffusion experiments is an indication of the least number of antigens concerned in the reaction The distance between the lower boundaries of the two bands shown by cord-blood hæmoglobin differed with different samples of cord blood (see Fig 1 and Table 1) Antigen 2 was prepared from the cord blood of a premature baby (35 weeks gestation) , antigens 3, 4 and 5 were prepared from the cord bloods of babies which were believed to be born at term Antigen 2 contained 87 per cent of fœtal (alkali-resistant) hæmoglobin estimated by the method of Jonxis[6] , antigen 3 contained 83 per cent of fœtal hæmoglobin Antigens 4 and 5 had been prepared as carboxyhæmoglobin and Jonxis's method could not be used

Fig 2 shows the flocculation times[7] observed in constant antiserum titrations when serial dilutions of the antigens reacted with the antiserum diluted 1 in 25 In contrast with the agar diffusion experiments, none of the titrations disclosed two distinct zones of reaction, but the shapes of the curves, particularly those for antigens 2, 3 and 4, suggest that more than one antigen–antibody system was involved The optimal ratios[5] of the antiserum determined in the titrations with the five antigens are recorded in Table 1 together with the flocculation times of the optimal mixtures, that is, the first mixture in each titration to show visible particles of precipitate With the hæmoglobin from the four cord bloods there is a correlation between the flocculation time of the optimal mixture and the distance between the lower boundaries of the two red bands observed in the agar diffusion experiments shown in Fig 1

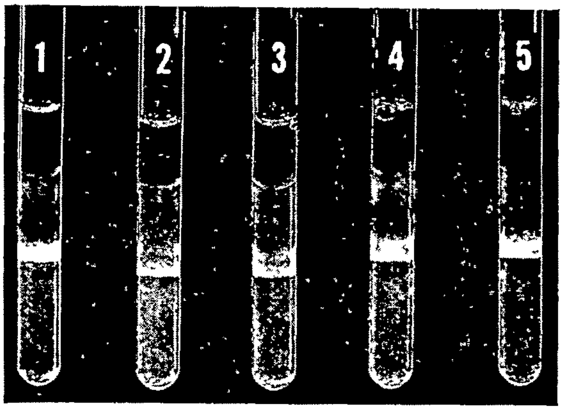

Fig 1 Precipitates formed in agar when an anti-adult-hæmoglobin serum reacts with adult hæmoglobin (antigen 1) and with hæmoglobin obtained from the umbilical-cord blood of four individual babies (antigens 2 to 5)

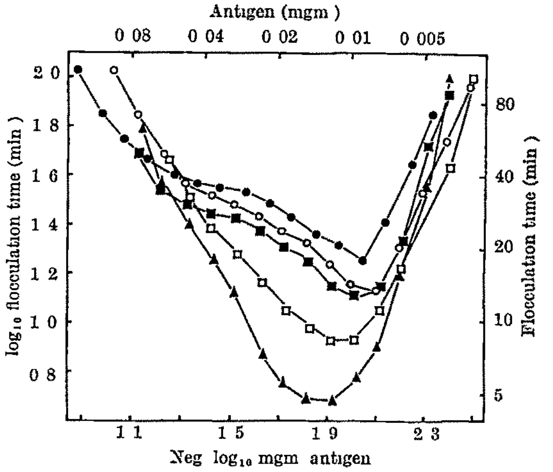

Fig 2 Constant antiserum titrations of an anti-adult-hæmoglobin serum with adult hæmoglobin (▲, antigen 1) and with hæmoglobin obtained from the umbilical-cord blood of four individual babies (●, antigen 2 , ○, antigen 3 , ■, antigen 4 , □, antigen 5) Antiserum diluted 1 in 25

A red precipitate containing 2 88 mgm protein was obtained when 1 ml of the antiserum was mixed with antigen 2 (cord-blood hæmoglobin) in slight antiserum excess of the optimal proportions When the antiserum was absorbed with an amount of antigen 2 which was approximately three times that in the optimal mixture, a bulky, bright red precipitate formed After centrifuging, the two bands of oxyhæmoglobin could be easily seen in the supernatant antiserum with a direct-vision spectroscope the presence of excess antigen was thereby demonstrated Addition of adult hæmoglobin to this supernatant antiserum gave a red precipitate which contained 1 17 mgm protein per ml antiserum Such distinction of adult and cord-blood hæmoglobin by absorption was not possible with all of twenty antisera examined, which showed considerable differences in the strength of their reactions with adult hæmoglobin after they had been absorbed in antigen excess with cord-blood hæmoglobin Some absorbed antisera failed to give a ring test with adult hæmoglobin during 2 hr observation, some reacted feebly and some yielded sufficient precipitate for quantitative determinations All these twenty antisera reacted rapidly with adult hæmoglobin before absorption

Aksoy[8] has cited experiments which show a lack of uniformity in the reactions of anti-cord-blood hæmoglobin sera absorbed with adult hæmoglobin In studies on the reactions of adult and of fœtal hæmoglobin with anti-adult-hæmoglobin sera prepared in chickens, Goodman and Campbell[9] found that individual antisera gave different values for the ratio between the maximum amounts of antibody precipitated by the two antigens In the present work similar results were obtained with antisera prepared in rabbits

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FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, December 29

Radar and Electronics Association (at the Royal Society of Arts, John Adam Street, Adelphi, London, W C 2), at 7 30 p m —Dr K R Sturley "High Quality Sound Broadcasting" *

Wednesday, December 30

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 2 30 p m —Dr J D Carthy "Animal Senses and Reactions" (First of two Juvenile Lectures Further lecture on January 6)

Institution of Electrical Engineers (at Savoy Place, London, W C 2), at 3 p m —Mr G G Gouriet "Colour Television" (Christmas Holiday Lecture To be repeated on Thursday, December 31)

Friday, January 1

Plastics Institute (in the Lecture Theatre of the Institution of Electrical Engineers, Savoy Place, London, W C 2), at 2 30 p m —Dr N A de Bruyne "Sticky Plastics" (Sixth Lecture for Young People)

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturer or Assistant Lecturer in Geography at Makerere College (The University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (December 30)

Graduate Assistant (with appropriate professional qualifications and/or experience) in the College Library—The Principal, Royal Holloway College (University of London), Englefield Green, Surrey (December 31)

Research Fellow (with a good degree in electrical engineering, physics or chemistry, and some research experience of vacuum systems) in the Department of Electrical Engineering—The Registrar, Queen Mary College (University of London), Mile End Road, London, E 1 (December 31)

Professor of Applied Mathematics—The Secretary and Registrar, University College of North Wales, Bangor, North Wales (January 1)

Lecturer (with a good honours degree in mining engineering and practical experience in mine surveying) in Mining Engineering and Mine Surveying—The Registrar, The University, Nottingham (January 9)

Lecturers (with a special interest in servomechanisms, measurements, high voltage or network theory) in Electrical Engineering —The Registrar, Manchester College of Science and Technology, Manchester 1 (January 9)

Lecturer or Assistant Lecturer in Chemistry at the University of Malaya (Singapore Division)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1 (January 15)

Chair of Chemistry—The Registrar, University College of Wales, Aberystwyth (January 16)

Visiting Professor in Oceanography at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (South Africa, January 31)

Head (with high academic qualifications in a branch of soil science or agronomy and considerable research experience and administrative ability) of the Soils Division, Rubber Research Institute of Malaya, Kuala Lumpur, for duties which will embrace the preparation, direction and development of a research programme in soil science nutrition of the rubber tree (*Hevea brasiliensis*) and general assistance in the advisory work of the Soils Division of the Institute—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Commonwealth Institute, Imperial Institute Road, London, S W 7 (March 1)

Assistant (preferably with some knowledge of horticulture and experience in proof correcting and indexing) to the Editor—The Secretary, The Royal Horticultural Society, Vincent Square, London, S W 1, marking envelope "Confidential"

Assistant Trials Officer (preferably with practical experience in crop production), to work at Leeds University Farm, Headley Hall, Yorks—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge

Chemistry Master (good sixth form work available for a man of the right qualifications)—The Headmaster, The School, Oundle, Peterborough

Cytologist or Cytogeneticist (with experience of chromosomal work) to work on human chromosomal anomalies—The Director of the Medical Research Unit, National Spastics Society, Department of Child Health, Guy's Hospital, London Bridge, London, S E 1

Editor and Technical Officer (with experience in editorial work, a sound knowledge of chemistry, and preferably familiarity with one or more foreign languages) to the Society of Dyers and Colourists —The Secretary, The Society of Dyers and Colourists, Dean House, 19 Piccadilly, Bradford, Yorkshire

Lecturer, Assistant Professor, and an Associate Professor in the Department of Mathematics—Prof E S Keeping, Mathematics Department, University of Alberta, Edmonton, Canada

Lecturer (with a good honours degree with teaching and industrial or research experience) in Mathematics—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex.

Organic Chemist, to participate in a biochemical research programme—Dr Sadler, Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London, W 1

Reader or Consultant in Nuclear Physics—The Principal, Bradford Institute of Technology, Bradford

Physicist (Senior Grade) (with previous experience in hospital physics), to work under the direction of the Principal Physicist in the Radiotherapy Department—The Superintendent, Guy's Hospital, London Bridge, London, S E 1

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SCIENTIFIC RESEARCH IN GREAT BRITAIN

THE tenth annual report of the Advisory Council on Scientific Policy*, covering the year 1958–59, deals with three main topics scientific man-power, space research and overseas scientific relations Of the first, it may be said that the Advisory Council comments briefly on the results of a further survey of scientific and engineering man-power made last winter by the Ministry of Labour and National Service along the same lines as that conducted in 1956 The Council agrees with the Scientific Man-power Committee that the experience of three years is an insufficient basis for a detailed re-assessment of the long-term demand, but its general comments are more conveniently discussed in considering this second report on Scientific and Engineering Man-power in Great Britain itself, which has been published separately

Besides these surveys, the main report refers briefly to the development of the National Lending Library of Science and Technology, which is now expected to be in full operation by 1962, and to the inquiries made during the year into research contracts of United States Agencies with British universities and institutions in an endeavour to assess the total amount of such financial support and the principles on which it is given On the former matter, it is startling to read that the Advisory Council believes that its responsibilities towards such schemes can now be regarded as satisfactorily concluded The report describes briefly what is being done in the way of buildings and the collection of scientific literature by the Lending Library Unit of the Department of Scientific and Industrial Research, and refers appreciatively to the sponsorship by this Lending Library Unit of translations of eight Russian periodicals

It is only two years since the Advisory Council first reported progress towards the establishment of a National Lending Library of Science and Technology, and even a year ago it was expressing concern at the failure to establish the National Reference Library of Science and Invention The two projects are inter-related and serious doubts are entertained by competent judges as to how far either is likely to be efficient in the absence of the other, apart from any question of duplicating resources For that reason and for the further reason that the Advisory Council's own recommendations for the National Lending Library included collaboration with the existing regional and specialist library services in the supply of scientific literature, this statement in the report reads rather like dereliction of duty Even with the appointment of a consultative committee to advise the Department of Scientific and Industrial Research from the point of view of the users of the Library on the services to be provided by it, the Advisory Council ought not to disclaim either responsibility or interest.

The Advisory Council's report does not mention the appointment of this committee, the membership of which has been announced, but, on the Advisory Council's own showing, an adequate lending and reference service of scientific libraries bears so closely on both the supply of scientific and technical man-power and its efficient use that the Advisory Council can scarcely avoid a continuing interest in the provision of such services Incidentally, the users do not seem to be adequately represented on that committee In any event, it will probably be necessary for the Council to continue to exert its influence in order to overcome the obstacles to co-operation and to ensure that adequate resources are placed at the service of the library system as a whole Indeed, from this point of view, although the Roberts Report on the Public Library Service was addressed to the Minister of Education, some comment on the report might have been looked for from the Advisory Council, for Sir Sydney Roberts's Committee gave due consideration to the relation of public libraries to other libraries, including scientific libraries

On the matter of research contracts with British universities and institutions, the Advisory Council estimates that financial support for research in Britain from Government agencies and charitable foundations in the United States amounts to about £1 5 million per annum, of which about 1 5 million dollars comes from charitable foundations, such as the Rockefeller, Ford and Kellogg Foundations, a like sum from United States civilian agencies such as the National Science Foundation, and about half that sum from United States Service departments and agencies , and most of the money from Government agencies has so far been in the form of contracts for specific projects While welcoming the substantial support this affords for research in Britain, the Advisory Council recognizes that research grants, and particularly specific contracts of this magnitude, could influence considerably the general pattern of research Accordingly, with the full co-operation of the United States authorities, who fully appreciate the position, it is seeking to extend to all such contracts existing arrangements by which all research contracts placed by United States Service departments are notified to the British departments and research councils concerned Without interfering with the freedom of university departments to accept or reject contracts which are offered to them, the arrangements should make it possible to co-ordinate British and United States offers of financial support for research, and should also ensure that the general terms of the various contracts are on a uniform basis. While the Advisory Council hopes that in future a substantial proportion of the funds available will be provided in the form of grants, its inquiries did not indicate that the terms of contracts and security considerations hindered either the freedom of the research worker concerned or the publication of his results

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* Annual Report of the Advisory Council on Scientific Policy 1958–1959 (Cmnd 893) Pp iv+14 (London H M Stationery Office, 1959) 1s net

The linking of research and other scientific activities in the United Kingdom is further illustrated in the section of the Advisory Council's report which deals with overseas scientific relations Reference was made in the Advisory Council's last annual report to the establishment by the North Atlantic Council of a Science Committee on which the United Kingdom representative is Sir Solly Zuckerman This Committee has recently set up a small study group of scientists, under the chairmanship of M Louis Armand, to review the whole field of scientific effort in the North Atlantic Treaty Organization countries, and to direct attention to underlying weaknesses or gaps, and the results of this study are expected to be available next year Under the Organization for European Economic Co-operation, which is at present reviewing its committee system, the Committee on Scientific and Technical Personnel has developed a senior visiting fellowhip programme, designed to enable research institutions to send their own research workers abroad, or to invite research workers from foreign institutions to visit them , this appears to be meeting a need in many countries The Committee on Applied Research also has developed a number of practical co-operative research projects

The Government's decision to set up an Overseas Research Council is warmly welcomed in the Advisory Council's report, which stresses the urgency and importance of the matters with which the new Council will have to deal Emphasizing the value of the contribution which the United Kingdom has to offer to the development of the overseas territories, the Advisory Council hopes that the new Council will both be able to advise Ministers on the type of assistance that is most needed and also act as a focus of interest in the application of research, both in and for the overseas territories The new Council should, it thinks, prove a useful complement in the scientific field to the work being undertaken in the educational field as a result of the recent Commonwealth Education Conference

The close relation between research and education in the overseas territories is one reason for hoping that, while the detailed activities in research overseas will doubtless in future be described in the annual reports of the Overseas Research Council, the Advisory Council on Scientific Policy will not cease to concern itself with the broad issues and with the inter-relations with research in other fields and with education Moreover, it has still to be seen if the Overseas Research Council can supply that overall conspectus of overseas research rather than the sectional reports, however admirable in themselves, to which "Colonial Research" has hitherto been limited Such a conspectus is increasingly desirable in view of the growth in scale and extent of research in the Colonial and other overseas territories, and of the collaboration with the United States in this field The appointment by the Lord President of the Council, pending the establishment of the Overseas Research Council, of a scientific panel, under the chairmanship of Sir Alexander Todd, to collaborate with a corresponding American panel, set up by the National Science Foundation in the United States, to prepare a report on the application of science to problems in Africa for the United States International Co-operation Administration is a step in the right direction

It was in accordance with the advice of the Advisory Council on Scientific Policy that the British Government authorized a programme for the design and construction of instruments to be carried in a series of Earth satellites, and with the establishment of a Steering Group under Sir Edward Bullard to supervise and co-ordinate the general Government interest in the programme, so that the direct concern of the Advisory Council with the present programme of space research terminated Nevertheless, the Advisory Council, in the present report, does not content itself merely with summarizing concisely the steps which led to the initiation of that programme, and the subsequent agreement of the United States National Aeronautics and Space Administration to provide space in a series of satellites to be launched over a period of three to four years for a number of British instruments designed to carry out a scientific programme under the general supervision of the British National Committee for Space Research It also takes the opportunity of setting out principles which it believes should underlie British participation in this field of endeavour

Space research, it is pointed out, especially when it proceeds beyond the stage of launching small Earth satellites, must make enormous and increasing demands on scientific and financial resources, and we in Great Britain cannot hope to provide all the resources necessary to develop space exploration independently on an equal footing with the United States and the U S S R Nevertheless, the Advisory Council is convinced that British scientists have an important and useful part to play in this new field, and that if they are provided with the means to carry their scientific instruments into space, carefully designed experiments with Earth satellites can contribute to the solution of important scientific problems and often provide the most economical method of obtaining the data needed Ventures into space with lunar, planetary or solar probes would be far more costly, and in the Advisory Council's opinion the scientific and technological return is unlikely to be commensurate with the cost British participation in such activities at the present time is not recommended

The Advisory Council does not expect the scientific programme at present authorized to have in itself any adverse effect on the man-power situation in British industry , indeed, there may be some stimulus to micro-instrumentation Nevertheless, the Advisory Council reiterates that the technological advantages likely to accrue from the development of a British rocket and satellite programme designed for civil purposes, over and above the effects of the existing military missile programme, would be insufficient to justify the very considerable expenditure involved When the results of the design studies at present being carried out on the adaptation of British military rockets are available, it will be possible to decide whether the additional expenditure and diversion of effort involved in a purely British satellite programme may be justified by the results which can be expected

The Advisory Council is not unmindful of the claims of prestige, but rightly it stresses the all-important question of priorities for a nation with limited resources Once again it emphasizes the importance of adequate expenditure on research and development in those fields which vitally affect the welfare of our people, the strengthening of our economic position and the improvement of standards of living in the under-developed countries, particularly in Commonwealth countries and Colonial territories It is incontestably right in urging that it would be the grossest folly to leave these needs unsatisfied in order to embark on a large programme of space exploration on a purely national basis, and in suggesting that in such a field the right approach is that of international collaboration

There may well be other fields in which the contribution appropriate to the special skills and resources available in Great Britain is best made on an international basis, and the newly established co-operative agreement with the United States already noted, and the further agreement for United Kingdom participation in a joint United States/Canadian Working Party to conduct experiments on the ionosphere by means of rockets are to be welcomed on general as well as on specific grounds The Advisory Council's latest report provides conclusive evidence of the value of the Council, provided that its authority is properly sustained and its recommendations are effectively presented It is manifest that Lord Hailsham, as Minister for Science, has at his hand an admirable instrument, with a realistic sense of priorities and the wide vision and clear understanding that are essential in securing co-operation and co-ordination in either science or technology

A HISTORY OF MAGIC AND EXPERIMENTAL SCIENCE

A History of Magic and Experimental Science
By Prof Lynn Thorndike Vols 7 and 8 The Seventeenth Century Vol 7 Pp x+695 Vol 8 Pp viii+808 (New York Columbia University Press, London Oxford University Press, 1958) 80*s* net each volume

THE publication by Prof Lynn Thorndike of Vols 7 and 8 of his great work, "A History of Magic and Experimental Science", completes a task on which he has been engaged for more than fifty years The first two volumes appeared in 1923[1], but the author's interest in the subject extends back to a much earlier stage in his career While still a student at Columbia University, New York, in 1902–3, it was suggested to him that a study of magic in medieval universities would form a suitable subject for a master's degree The more immediate outcome of his initial researches in this field appeared in 1905, in a book entitled "The Place of Magic in the Intellectual History of Europe This was followed by his "History of Medieval Europe"

After leaving Columbia, Prof Thorndike served as associate professor of history in the Western Reserve University, and while there the first two volumes of his *magnum opus* were published Shortly afterwards, in 1924, he returned to Columbia on appointment as professor of history in that University It is evident that by this time Prof Thorndike had already acquired a deep interest in the history of science, for he was one of the founder members of the History of Science Society established in the United States in 1924, later serving as its president, and in 1928 he was instrumental, with others, in setting up the Académie internationale d'Histoire des Sciences It is from the fusion of these two interests, medieval history and the history of science, that his eight-volume work has grown

The first two volumes cover the first thirteen centuries of the Christian era They were reviewed by George Sarton, in *Isis*[2], and the review was a critical one While admitting that the work was one of major importance, the reviewer expressed the opinion that the title was so misleading as to be deceptive In Sarton's view, it was not a history of the science of the period, still less of experimental science, as these two terms should be understood While there is something to be said for Sarton's point of view, it seemed a little pedantic, because, as he later admitted, what passed for science in medieval times was, for the most part, inseparably linked with the practice of astrology, alchemy and divination, and with the lore of gems and amulets

Volumes 3 and 4 were published in 1934, and cover the fourteenth and fifteenth centuries In Vol 3 (p 22) Prof Thorndike met Sarton's criticism, intentionally or otherwise, with the statement that his work was to be regarded as a history of the relations between magic and experimental science, and this certainly defines the scope of the work rather more closely These two volumes also were reviewed by Sarton[3], and this time, while repeating his opinion that the title was misleading, he was less critical, and he conceded that, since medieval thought was governed by astrology, alchemy and divination, Prof Thorndike's work might be called a history of scientific thought He pointed out, not unreasonably, that the term 'experimental science' was used by the author in far too loose a sense

Vols 5 and 6, which appeared in 1941, cover the sixteenth century, and, in Vol 5 Prof Thorndike, in discussing the first six volumes, states "Like Moses we have brought the reader through the wilderness to within sight of the promised land of modern science It remains to be seen whether we shall enter in or whether we shall content ourselves with viewing the prospect o'er from the other—magical—side of Jordan" Fortunately, the author decided to cross this intellectual Jordan, and continues his story to the end of the seventeenth century in his last two volumes

Prof Thorndike has deliberately restricted his study, in time, to the Christian era, and in space to the Western world In these last two volumes he has moved forward to the seventeenth century, to the period when the great expansion in the search for knowledge took place, which has been called by Dr Charles Singer the 'insurgent' century and by others one of scientific revolution It is in this period that many of the experimental and observational sciences have their main roots and begin to take on a more modern form, and for this reason Vols 7 and 8 are likely to have a wider appeal than the earlier ones Their main thesis, however, is the extent to which the belief in magic and the occult, universal in preceding centuries, lingered on through the seventeenth century, even in the minds of learned men, a fact that is not usually emphasized in the more conventional histories of science, though the evidence is ample These last two volumes provide a link between the age of magic and that of modern science

The two volumes cover 1,500 pages, and it is impossible to discuss their contents in detail within the limits of a review, but the following selection from the titles of the forty chapters gives an indication of the field covered Vol 7 includes the following "Backward Glance", "Kepler and Galileo", "Francis Bacon", "Alchemy and Iatro-Chemistry to 1650", "Mineralogy", "Natural Magic", "Interest in the Occult in German Universities", "Harvey and Patin", "Descartes", "The Underground World of Kircher and Becher", and "Artificial Magic and Technology" Vol. 8 has chapters on "Natural History, especially of Animals", "Botany", "Chemical Courses and Manuals", "Robert Boyle", "Academies and Scientific Societies", "Astrology after 1650", "Medicine and Physiology", "Illicit Magic", "Sir Isaac Newton", and "The Last Decade"

Prof Thorndike's treatment of the scientists and subjects discussed always emphasizes the credulity of the age His opinions are personal views, uninfluenced by the generalizations of other writers, and based solely on his own very extensive reading For example, of Robert Boyle he writes "In Boyle himself we have an example *par excellence* of one beginning to shuffle off the mystic robes of the magician and putting on the habiliments of modern science", but he considers the statement by a recent biographer of Boyle that the latter is generally known to have been an alchemist, "accepting theoretically and practically the doctrine of the transmutation of the elements"[4] is too strong an estimate of Boyle's position Some chapter headings might lead the unsuspecting reader to anticipate a discussion of the beginnings of systematic knowledge of some particular science, but he is likely to be disappointed That on mineralogy, for example, is almost solely concerned with the belief in the supposedly occult or medicinal properties of gems and minerals.

Prof Thorndike's work is in no sense a systematic or even a complete history of experimental science, or of science in general It is a very detailed and fully documented account of beliefs that held sway for centuries before the scientific revolution, beliefs that were so deeply ingrained in the human mind that they were only with difficulty discarded by the scientists and naturalists who actually brought about this revolution It is a work of great erudition The author records that in the last two volumes some 1,600 authors and men of learning are mentioned To the majority of readers most of these names are likely to be unfamiliar, if not entirely unknown If known, the books they wrote (some exist only in manuscript form) are frequently of such rarity as to be difficult of access to the average reader, and, furthermore, the fact that many are written in Latin means, to all but the few, that even if accessible they are unreadable Historians of science will be permanently in the author's debt for placing on record, in readable form, the results of his researches, which were carried out in many European libraries, as well as in those in the United States It is perhaps inevitable that these volumes often read as if they represent the transcription of a series of tidied-up note-books, interspersed with the comments of the author This is not to say, by any means, that the text is not easy reading, for it can be read with interest and pleasure, but it is regrettable that the author's conclusions on the numerous topics discussed are not summarized more often and more systematically

"The History of Magic and Experimental Science" is primarily a source-book and a work of reference, and as such is likely to be consulted for many years to come It is also a mine of bibliographical information Use of the book is greatly facilitated by the elaborate index, contained in Vol 8, which extends to 168 pages It seems unlikely that the ground covered by Prof Thorndike in these two volumes, and, indeed in the whole work, will ever again be re-traversed in such detail As a history of magic it is outstanding, as a history of science it should be read in conjunction with the more formal histories of science It is a pleasure to record that in December 1957 the author was presented with the George Sarton Medal, the highest award of the History of Science Society, for his numerous and valuable services to the history of science V A Eyles

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[1] A second printing, with corrections, was published in 1929

[2] *Isis*, 6, 74 (1924)

[3] *Isis*, 23, 471 (1935)

[4] Moore, L T, "The Life and Works of the Honourable Robert Boyle", 214 (Oxford, 1944)

OLD CHEMISTRY

Chymia

Annual Studies in the History of Chemistry, Vol 5 Edited by Henry M Leicester (Edgar F Smith Memorial Collection University of Pennsylvania University of Pennsylvania and Division of History of Chemistry, American Chemical Society) Pp 214 (Philadelphia University of Pennsylvania Press, London Oxford University Press, 1959) 40*s* net

It is six years since the previous volume of "Chymia" was published and it is good news that this attractive and valued selection of studies in the history of chemistry is again to appear annually The American Chemical Society has furthered the interests of chemistry in a way which is internationally acknowledged and esteemed, and the inclusion of the history of chemistry in *Chemical Abstracts* for a long time has shown that it has this side of its many interests at heart The editor of the present volume, well known for his valuable publications in the field, contributes an interesting paper on the spread of the theory of Lavoisier in Russia The volume begins with a well-deserved tribute to the memory of Edgar Fahs Smith (1854–1928) and a list of his numerous publications relating to the history of chemistry, written by H S Klickstein In a way, "Chymia" owes its existence to Edgar Fahs Smith, and his memorial collection in the University of Pennsylvania, left with an endowment, now includes part of C A Browne's collection and the library of Tenney L Davis, making up more than nine thousand volumes and three thousand portrait prints

The other papers cover a wide field, from ancient Mesopotamian metallurgy to the history of the structure of acetone One of the longer papers, by Daumas and Duveen, describes Lavoisier's large-scale decomposition and synthesis of water in February, 1785 There is an article by R E Schofield on Josiah Wedgwood as an industrial chemist and one by R Siegfried on the chemical philosophy of Humphry Davy American chemistry is represented by two papers, one on the Columbian Chemical Society by W D Miles and one by S M Edelstein on the chemical revolution in the United States as shown by the pages of the *Medical Repository*, a periodical initiated by Samuel Latham Mitchill in 1797 This paper is of interest in relation to Priestley, who published in Mitchill's journal

One can always have too much of a good thing, when interest tends to decline With such a relatively small publication as "Chymia", appearing once a year (as we hope it will), it follows that only material of the highest standard can find a place It can be read, and since its field is restricted to chemistry it is not swamped by publications towards which chemists, with their generally practical and objective outlook, feel little drawn Chemists can read and enjoy it, and even those who have little sympathy with historical studies as such cannot fail to find something in the pages of "Chymia" which will interest them We all know who proposed the name "aldehyde" Who first used the name "acetone" ? A search of all the standard literature does not answer this question, but it is answered in this volume of "Chymia" Every chemist who up to now has not seen this fascinating publication is strongly advised to repair his loss

J R Partington

PROPERTIES OF LIQUIDS

Liquids and Liquid Mixtures

By Dr J S Rowlinson (Modern Aspects Series of Chemistry) Pp ix+360 (London Butterworths Scientific Publications , New York Academic Press, Inc , 1959) 75*s* , 12 80 dollars.

DR ROWLINSON'S book is admirable in many ways In it is gathered together an impressive amount of quantitative information about the measured properties of liquids and liquid mixtures, and also a multitude of thermodynamics and statistical formulæ, including all those that are ever likely to be required for the correlation of purely thermodynamic properties No reader could possibly complain that the author has paid inadequate attention to the experimental literature, or has failed to take seriously the difficulties which arise in the most advanced statistical theories

The book, however, suffers from the defects of its qualities It is a commonplace that nothing but trivialities can ever emerge from a purely thermodynamic discussion of homogeneous phases, and yet the statistical theory of liquids does not appear until two-thirds of the way through the book One of the most valuable generalizations in the theory of liquids is the principle of corresponding states, and one would have thought that this principle, and its statistical basis, should have been introduced early on, as an invaluable first approximation from which real liquids, of course, deviate to varying degrees and for various reasons Again, the thermodynamic properties of mixtures cannot be understood at all without reference to the intermolecular potentials, and surely the most satisfactory way of dealing with them is to interpret the data in terms of statistical models as one goes along In this connexion it is a pity that nothing is said about the theory of Prigogine and his colleagues of 'ideal associated' solutions, or about the link-up between the spectroscopic and thermodynamic data on alcohol solutions Further, though this is a fault of the title rather than of the book, there is virtually no mention of transport properties, or of other non-thermodynamic measurements which have thrown so much light on the liquid state

The best chapters in the book are probably those on the critical state of pure liquids and liquid mixtures, and the final chapter on the statistical thermodynamics of mixtures of spherical molecules, which is based mainly on the work of W B Brown

Finally, it is certain that the purely descriptive chapters on the phase diagrams of mixtures will be of educational value to the chemical engineer, for whom the moral of the book is "Anything can happen and it probably will" H C Longuet-Higgins

SOILS OF TANGANYIKA

A Survey of Soils in the Kongwa and Nachingwea Districts of Tanganyika

By B Anderson Pp ix+120 (36 figures) (Reading . Department of Agricultural Chemistry, The University , Dar-es-Salaam Tanganyika Agricultural Corporation, 1957) n p

EVERYONE knows the dismal sequel to the ambitious scheme for the mechanized production of ground-nuts in East Africa, which was characterized by the failure to employ pedological methods on pedological problems After the horse had departed, some effort was made to shut the stable door and a very competent soil surveyor was set to work to make a proper study of the soils of the Kongwa and Nachingwea districts The publication under review presents his results and shows what can be achieved by one trained pedologist working 'on the cheap' with limited facilities, but with specialized technical assistance from various institutions The moral for would-be planners of land-use is obvious

The first two chapters contain descriptions of the topography, geology, climate, vegetation and soils of the two areas In each case the soils are described in detail and the soil patterns are shown on maps at 1/25,000 The latter are clear and pleasing to the eye, but the keys should have specified the parent material and topographic situation of each soil series, thus saving constant reference to the text

At Kongwa the main catena consists of red earths developed on a sandy loam from granitic gneiss and brown and grey calcareous valley-soils on colluvium and alluvium Some of the red earths are capable of cropping usefully in good years but the main limitation is the unreliability of the rainfall

In the Nachingwea area, the major areas are occupied by a 'textural catena' developed by differential washing of a deep mantle weathered from more basic gneiss The rainfall is nearly twice as high as at Kongwa and the wet season is somewhat longer

The next chapter describes the soil maps in detail and clarifies the topographic relationships with cross-sections In the last, there is a useful summary of ideas on the genesis of the soils and their relations to other tropical soils

The book is well illustrated with photographs and diagrams and is a valuable addition to our knowledge of East African soils R M S Perrin

Acoustique Musicale

(Marseilles, 27, 28, 29 Mai, 1959.) (Colloques Internationaux du Centre National de la Recherche Scientifique, No. 84.) Pp. 259. (Paris: Editions du Centre National de la Recherche Scientifique, 1959.) 3,400 francs.

FROM time to time the subject of musical acoustics earns itself a colloquium. There was one recently in London (see *Nature*, 183, 1293; 1959) and others have taken place in Switzerland and the United States. The colloquium the proceedings of which are under review was more ambitious, since from its audience it could be justly called international and was conducted at Marseilles, surprisingly under the patronage of the Centre National de Recherche Scientifique. Such gatherings usually attract a number of scientists who are amateur musicians but few professional musicians. The organizers of this one were fortunate in collecting an audience nearly equally divided between the two types. The papers presented indeed, with a few exceptions, fell into two classes, those concerned with the acoustics of musical instruments (the scientific) and those with intonation and musical scales (the arithmetic, if the writer of this notice may be pardoned for using the term). A surprising amount of 'academic' discussion was engendered concerning the effects of changing an interval in a scale by a small fraction say, a few cents, academic because real singers and instrumentalists do not hold intonation to such a precision.

One may have doubts whether this subject is an art or a science, but many readers of these proceedings will gain a refreshing insight into the range of interest and activity covered by the term 'musical acoustics'.

E. G. RICHARDSON

Biological Sciences

Vol. 2. Edited by J. G. Bugher, J. Coursaget and J. F. Loutit. (Progress in Nuclear Energy, Series 6.) Pp. x+422+xii. (London and New York: Pergamon Press, 1959.) 105*s.* net.

THIS is an editorial selection of thirty-five papers out of the many presented to some of the biological and medical sessions of the Second Conference on the Peaceful Uses of Atomic Energy (1958). The subjects range from the distribution of labelled drugs in the body, to radiation-induced ageing in mice and induced mutations in polygenic systems. The reviewer can only apply a further arbitrary selection. A remarkable paper by Barnes, Ford, Gray and Loutit reports the discovery that repopulation of hæmopoietic tissue by host cells in radiation-chimæra is often effected by a very few clones of cells, sometimes recognizable by chromosomal 'markers'.

Ullberg gives some beautiful examples of how the distribution, localization and metabolism of certain (labelled) drugs can be followed by auto-radiography; Muller reviews the recent contributions of *Drosophila* work to the knowledge of radiation-induced mutation.

General papers deal with the 'ageing' effects of radiations and, more generally, with the effects on the life-span. Others deal with agents modifying the biological effects of radiations, with the elimination of radioactive substances from the body and with chemical effects of radiations on particular substances. A considerable proportion of the book is concerned with the induction of mutations.

The book is an indispensable—though somewhat expensive—reference for laboratories in any way concerned with the biological effects of radiations.

G. PONTECORVO

Tracer Applications for the Study of Organic Reactions

By John G. Burr, Jr. Pp. x+291. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1957.) 7.50 dollars.

IN this book the author has attempted to present the evidence obtained by the use of isotopic tracers in the study of organic reaction mechanism. A very wide field has been covered, and in some sections, for example, that on migration aptitudes, a valuable critical discussion has been included. It is rather a pity that this standard has not been adhered to throughout and the work thus becomes rather uneven. Its main value lies in the full literature index which forms a most useful guide to further reading on the many reactions discussed. The literature coverage (up to early 1953) makes certain sections out of date at the time of writing but the author feels that the book will be of some value to the advanced worker who wishes to use it as a literature source book. Valuable appendixes on the subjects of reaction mechanism and handling of isotopic tracers, together with an additional list of references covering the period 1953–1954, are also included.

A. I. SCOTT

Index of Chemistry Films

A Comprehensive List of Films and Filmstrips on Chemistry and Related Topics. Pp. ix+150. (London: Royal Institute of Chemistry, 1959.) 5*s.*

THE object of this publication is to provide an up-to-date guide to the eight hundred or so films and two hundred or so film strips on chemical topics that are available in Great Britain. The films are classified according to subjects. Brief information is supplied on how any film may be obtained, on its length, gauge, essential contents and, where known, suitability for particular audiences, especially schools. This is a most valuable pamphlet, the existence of which should be made widely known so that fuller use can be made by schools and other institutions of the extensive amount of available material.

Royal Institute of Chemistry Monographs for Teachers

No. 1: Principles of Electrolysis. By Prof. C. W. Davies. Pp. v+30. 3*s.* 6*d.* No. 2: Principles of Oxidation and Reduction. By Dr. A. G. Sharpe. Pp. v+30. 3*s.* 6*d.* (London: Royal Institute of Chemistry, 1959.)

EVERY student who goes up to university soon encounters the frustrating experience of having to 'unlearn' something of what he has been taught at school. There may well be something to be said for the educational value of varied approaches and the discarding, on the basis of more adequate arguments, of material acquired parrot-fashion at a younger age. There can be no doubt, however, that such lessons ought to be kept to a minimum and that time at school is in general more wisely spent on the teaching of fundamentals on a sound basis.

With this object in mind, the Royal Institute of Chemistry have now begun the issue of pamphlets on some of the more advanced topics of the school chemistry syllabus, to provide a short refresher course for teachers. The venture deserves every success and has had a good send-off with the two pamphlets issued so far.

V. GOLD

GENETIC BASIS OF THE THALASSÆMIA DISEASES

By PROF. V. M. INGRAM and A. O. W. STRETTON
Division of Biochemistry, Department of Biology, Massachusetts Institute of Technology, Cambridge, Massachusetts

IN recent years it has become clear that the abnormal human hæmoglobins, such as hæmoglobins *S*, *C*, *D*, *E*, etc., are variants of the normal protein (hæmoglobin *A*), differing from it by the substitution of perhaps not more than a single amino-acid residue by a new one[1]. These mutant forms are inherited as single genes. On the other hand, thalassæmia in both its minor and its major form, although inherited in a similar manner, has presented a much more complicated and confusing picture. In this anæmia, the inherited abnormality is not manifested in the production of recognizably abnormal forms of hæmoglobin, but rather in the apparent interference with the rate of production of the hæmoglobin *A* with consequent anæmia.

It is the purpose of this article to present and explore a unifying hypothesis—and an alternative—which seeks to explain the occurrence of thalassæmia and some of its interactions with the other hæmoglobinopathies in which chemically abnormal hæmoglobins are recognized. In particular, we wish to suggest that thalassæmia is a mutation producing a hæmoglobin with a 'hidden' amino-acid substitution, such that the hæmoglobin produced is electrophoretically normal. There are many such mutations possible. Some of the ideas which are contained in this theory have been talked about by many people and on numerous occasions (for example, Itano[2]); we do not wish to claim any great originality for them. It is hoped that the hypothesis, even if proved wrong, will serve to stimulate interest and direct experiment in this field.

Historical

Thalassæmia, or Cooley's anæmia, is a hereditary disease which occurs commonly in Mediterranean peoples, especially those of Italian and Greek origin. It is found in two forms, thalassæmia major, or Cooley's anæmia, and thalassæmia minor.

Clinically the major form of the disease is characterized by a marked hypochromic anæmia with abnormal red-cell morphology and the presence of target cells and oval red blood cells; the cells have increased mechanical fragility and osmotic resistance. The minor form, on the other hand, may be asymptomatic and in some cases is difficult to diagnose. Anæmia, if present at all, is only very slight; the hæmatological findings include increased target cells, microcytosis, and increased osmotic resistance of the cells.

Electrophoretic studies[3] and measurements of the rate of denaturation by alkali have shown that in the major form of the disease the proportion of a hæmoglobin having the mobility and behaviour of fœtal hæmoglobin is raised, sometimes as high as 97 per cent of total hæmoglobin. In the minor form the proportion of fœtal hæmoglobin is scarcely raised above the normal amount, which is of the order of 1 per cent. Rich[3] has suggested that fœtal hæmoglobin is produced to compensate for the marked decrease in the amount of normal adult hæmoglobin synthesized by people with thalassæmia major; if this is the case, it is apparent that the degree of compensation varies widely from individual to individual, as does the decrease in the rate of production of hæmoglobin *A*.

It is now well established that the parents of a person with thalassæmia major have thalassæmia minor, and extensive family studies have been carried out to support this[4]. However, cases have been reported where parents of thalassæmia major children do not show the usual findings associated with thalassæmia minor[5]. In addition to the increase in the proportion of fœtal hæmoglobin mentioned above, Kunkel[6,7] has recently shown a correlation between the proportion of a normal minor component of blood, hæmoglobin A_2, and the presence of a thalassæmia gene. Gerald and Diamond[8] have extended this in a survey of twenty-three parents of children with thalassæmia major. They found that in all these parents the proportion of A_2 is raised, the usual increment being from the normal 2.5 per cent to 5 per cent. However, Kunkel *et al*.[7] showed that two out of thirty-four parents of children with thalassæmia major had no increase in A_2, although examination of their blood suggested the presence of thalassæmia minor. This last finding suggests, as does the great variability of the disease, that there is not one kind of thalassæmia minor or major, but several and perhaps many.

Possible Molecular Mechanisms for Thalassæmia

The appearance of the cells in thalassæmia major suggests that they contain less hæmoglobin than normal. Perhaps such symptoms as are seen in the minor condition can be laid to this cause also. It is possible to explain the low hæmoglobin content in terms of a slower rate of hæmoglobin synthesis within the developing blood cell in a way similar to the explanation given by Itano[9] for the abnormal hæmoglobin diseases. If we assume that hæmoglobin synthesis is complete in all or almost all the cells in circulation, then the ratio of the amounts of different hæmoglobins in the same cell is equal to the ratio of their average rates of synthesis. In persons who are heterozygous for hæmoglobin *A* and for an abnormal hæmoglobin (for example, hæmoglobin *S*), the proportion of hæmoglobin *A* is usually higher than that of the abnormal, reflecting a lower rate of synthesis of the abnormal hæmoglobin. It has been suggested[9] that in cases of persons homozygous for an abnormal hæmoglobin or heterozygous for two abnormal hæmoglobins, the cells are microcytic and the blood contains numerous target cells. However, in sickle cell anæmia, the cells are normocytic, but this may be due to increased amounts of fœtal hæmoglobin in the cells. Since all the cells in sickle cell anæmia show the sickling phenomenon, even when hæmoglobin *F* is present, the synthesis of fœtal hæmoglobin and hæmoglobin *S* seems to occur within the same cells[10].

A slow rate of hæmoglobin synthesis in thalassæmia might be expected to result in hypochromic cells. We know of no direct experimental evidence on whether fœtal hæmoglobin produced in thalassæmia major is in the same cells as adult hæmoglobin; but arguing from the findings in sickle cell anæmia, we would predict that they would be in the same cells. Experiments are needed to confirm this prediction and to compare the sites of formation of cells containing fœtal hæmoglobin in the normal fœtus and infant, in sickle cell anæmia and in thalassæmia major.

Possible Causes of a Low Rate of Hæmoglobin Synthesis

If the gene affected in thalassæmia is one which controls the production of an enzyme catalysing one of the many steps involved in hæm synthesis, a low rate of enzyme synthesis or a defective enzyme might result in this particular enzymatic reaction being the rate-limiting step in hæmoglobin production. The high serum iron and the saturation of the iron-binding capacity of the plasma have been taken as indications that inhibition in porphyrin synthesis is the basic defect in thalassæmia. However, on this basis it would be expected that the rate of synthesis of fœtal hæmoglobin should also be reduced in thalassæmia, if indeed it is true that fœtal and adult hæmoglobin are made in the same cells.

In the normal infant, a switch-over mechanism exists which causes fœtal hæmoglobin production to be replaced completely by adult hæmoglobin production within a few months of birth. The nature of this control mechanism is not understood; but if it were defective, fœtal hæmoglobin synthesis might not be arrested, as it is in the development of the normal infant, while at the same time the synthesis of hæmoglobin A might remain partially or completely unstimulated. Thalassæmia, in this view, would be a developmental defect, resulting in a state of immaturity of the hæmoglobin-synthesizing system.

The two mechanisms discussed above might be expected to result in a low rate of synthesis of adult hæmoglobin, and it is quite possible that some cases of thalassæmia are, in fact, caused by one or other of them. However, there is one aspect of the effect of a thalassæmia gene that is difficult to explain in these terms: it is found that in many cases where both clinical and family studies suggest the presence of both a thalassæmia gene and a gene for an abnormal hæmoglobin (for example, hæmoglobin S) in the same person, the proportion of abnormal hæmoglobin is roughly doubled in comparison to that found in a person singly heterozygous for an abnormal hæmoglobin. For example, in sickle cell or hæmoglobin C trait, the abnormal hæmoglobin constitutes roughly 40 per cent of the hæmoglobin, whereas in double heterozygosity for thalassæmia and hæmoglobin S or C, the proportion rises to about 80 per cent. The remainder is largely fœtal hæmoglobin. This indicates a specific inhibition of hæmoglobin A synthesis with little or no interference with production of the abnormal hæmoglobin. This differential effect is difficult to explain, if thalassæmia involves an effect on hæm synthesis, or a defect in the hæmoglobin F to hæmoglobin A switch mechanism, both of which should, *a priori*, inhibit also the abnormal hæmoglobin.

Studies on the ratio of hæmoglobin A to hæmoglobin S and to hæmoglobin C in heterozygotes have led Itano[11] to postulate that as well as containing the information for the amino-acid sequence of the globin, the hæmoglobin genes also have characteristic rate-determining information; thus, a gene controlling the production of a globin with a certain amino-acid sequence will effect synthesis of protein at a certain rate, while a gene associated with a globin having the same sequence except for one amino-acid may have a different rate of synthesis. For example, hæmoglobins S, C and E appear to be produced at a slower rate, and hæmoglobin J[9] at a faster rate, than normal.

Itano has also postulated[2], on the basis of the trimodal distribution of ratios of hæmoglobin A to hæmoglobin S in heterozygotes, that normal hæmoglobin is controlled by a series of at least three alleles, producing hæmoglobin at different rates; the hæmoglobins would have different amino-acid sequences, but the same electrophoretic mobility. We wish to extend these ideas to include thalassæmia, postulating that the 'hæmoglobin A' found in thalassæmia homozygotes has a different amino-acid sequence from 'normal', and that this new sequence determines a characteristically low rate of synthesis. If in some cases of thalassæmia major no hæmoglobin A appears to be produced at all, we would assume it to be due to a 'lethal' mutation similar to those found in micro-organisms where a mutation within a gene may cause no protein to be produced; so far only one such thalassæmia case has been described[3].

Amino-Acid Substitution Hypothesis

There are in the human at least three types of hæmoglobin: (*a*) the adult series of hæmoglobins (A, S, C, D, E, etc.), (*b*) the fœtal series (F, hæmoglobin 'Alexandra', etc.), (*c*) the normal minor components—for example, hæmoglobin A_2 of Kunkel and Wallenius[12].

Each form of hæmoglobin has, or probably has, four polypeptide chains of two different kinds[13,14], which we may write Hb $A = \alpha_2{}^A\beta_2{}^A$, Hb $F = \alpha_2{}^{\text{‘}A\text{’}}\gamma_2{}^F$, Hb $A_2 = x_2{}^{A_2}y_2{}^{A_2}$ (to indicate that these have not yet been investigated). The subscripts have the usual chemical significance as in H_2O and the superscripts refer to the particular hæmoglobin. It has been shown that the α chains of hæmoglobin F are like the α chains of hæmoglobin A in gross structure[17,18]. When it is shown that they are alike in detail, then we will be able to write hæmoglobin $F = \alpha_2{}^A\gamma_2{}^F$. The possibility that these α chains are identical, and more important, the possibility that those chains are controlled by the same gene, are of great genetic, developmental and evolutionary significance. They also affect to some extent the hypothesis in this paper.

It is widely believed that the precise amino-acid sequence, and hence the structure, of each hæmoglobin peptide chain is controlled by a specific gene—with the proviso mentioned in the previous paragraph. For hæmoglobin A there would exist α genes to control α chains and β genes to control β chains. The genotype of a person making hæmoglobin A would be written as α^A/α^A, β^A/β^A. The idea that two sets of genes might control production of hæmoglobin has been proposed before by Schwartz *et al.*[19] and by Smith and Torbert[20]. The genotype for fœtal hæmoglobin, and for A_2, can be written $\alpha^{\text{‘}A\text{’}}/\alpha^{\text{‘}A\text{’}}$, γ^F/γ^F and X^{A_2}/X^{A_2}, Y^{A_2}/Y^{A_2}. The abnormal human hæmoglobins, in so far as they have been investigated, have proved to carry single amino-acid substitutions in one or other chain[1]. The molecule of the hæmoglobin S phenotype which has the mutation

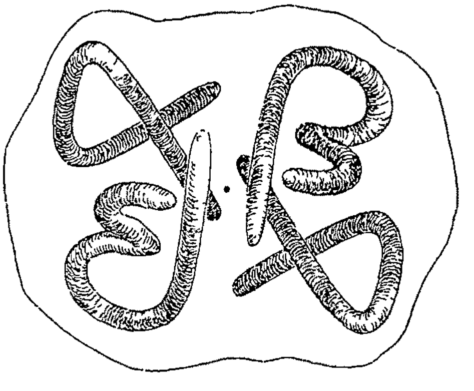

Fig 1 Schematic diagram of the spatial arrangement of peptide chains in the hæmoglobin molecule The sausage-like objects (ref 16) represent the coiled polypeptide chains which are of two sorts α peptide chains, beginning with the sequence valine-leucine, and β peptide chains, beginning with valine–histidine-leucine They are arranged about a two-fold axis of symmetry (according to Perutz *et al* , ref 15) perpendicular to the plane of the paper

in the β chain[21,23] is written as $\alpha_2^A\beta_2^S$ and the genotype as α^A/α^A, β^A/β^S and α^A/α^A, β^S/β^S for the heterozygote and homozygote, respectively Hæmoglobin *I*, which is an α chain mutation[21], would be written as $\alpha_2^I\beta_2^A$ and α^I/α^A, β^A/β^A in the heterozygote

It is an important feature of the chemical work of establishing the phenotype of the abnormal hæmoglobins that both forms of the genotype find their phenotypic expression The above sickle-cell heterozygote makes both hæmoglobin *A* and *S* This is not necessarily so and one can well imagine instances where the mutation might be so drastic or of such a nature that the phenotype—the corresponding chain —cannot be made We believe that some cases of thalassæmia may fall into this category

We wish to propose that, in its typical form, thalassæmia is a mutation of the α or the β gene of the adult series, in no way different from those mutations which lead, for example, to hæmoglobin *S* and *C*, except that the consequent amino-acid alteration does not change the electrophoretic behaviour of the hæmoglobin or that the alteration is so drastic that this particular chain is not made at all and therefore never observed So far we have confined ourselves to mutations which effect amino-acid substitutions at a point—point mutations It will be obvious that the above second class of alterations, leading to non-production of the chain, could also be caused by other types of mutations such as deletions, inversions and substitutions involving a considerable number of amino-acids

It is assumed for the time being that the four genes involved in, say, α^A/α^A, β^A/β^A, act independently and produce the chain peculiar to them Thus, the genotype α^I/α^A, β^A/β^S, if it existed, would produce $\alpha_2^I\beta_2^A$ = Hb *I* , $\alpha_2^A\beta_2^A$ = Hb *A* , $\alpha_2^A\beta_2^S$ = Hb *S* , $\alpha_2^I\beta_2^S$ = Hb *X* as yet unknown The elegant re-association experiments by Singer and Itano[22] and of Vinograd, Hutchinson and Schroeder[23] have shown that real hybrid molecules, such as $\alpha^I\alpha^A\beta_2^A$, for example, do not occur naturally and cannot so far be made *in vitro* It is also possible that a metabolic link exists between the α and the 3 gene derived from a particular parent, such that the genotype α^I/α^A, β^A/β^S makes only hæmoglobin *I* and hæmoglobin *S* There is as yet no definite evidence against this idea, but it seems to us unlikely

One important consequence of the theory is that thalassæmias, which have always been diverse in characteristics and distribution, can now be divided into two classes affecting the α and the β gene However, within each class, great diversity is just what one would expect, because the number of possible mutations leading to 'non-electrophoretic substitutions' must surely be very large They can differ in the particular amino-acid affected provided that such changes do not lead to alteration in electrophoretic behaviour, and consequently they can differ in the extent to which the rate of synthesis has been altered On this basis the 'thalassæmias' range from mutant forms which are almost indistinguishable from the normal, even by chemical examination, to those in which the mutation is so drastic—lethal—that the hæmoglobin is not made at all The genotypes of such thalassæmias might be written as α^A/α^X, β^A/β^X or α^A/α^A, β^X/β^A, with many different alleles. (Superscript '*X*' refers to the altered gene)

Although many such thalassæmias are theoretically possible, in practice they need not form a continuum Only some may be clinically important and therefore recognizable

One of the appealing consequences of the hypothesis is that it provides an acceptable explanation of the cases where the thalassæmia gene, when present together with a single hæmoglobin *S* gene, suppresses the formation of hæmoglobin *A* but not that of hæmoglobin *S*. Previous ideas which postulated that thalassæmia is a suppression of hæmoglobin synthesis have come up against the difficulty that this suppression can act selectively against hæmoglobin *A*, but not against the abnormal hæmoglobins such as *S*, *C* and *E* , this is in spite of the fact that each of these differed by only 1 out of 280 amino-acids[24] from hæmoglobin *A* and from each other We have always found such a situation difficult to visualize If, on the other hand, thalassæmia is a mutation of, say, the β gene, then a sickle cell-thalassæmia might have a genotype such as α^A/α^A, β^X/β^S This phenotype would not have the genetic equipment to make any hæmoglobin *A*, but would produce hæmoglobin *S* together with a reduced amount of $\alpha_2^A\beta_2^X$ (electrophoretically identical to $\alpha_2^A\beta_2^A$) As a compensating mechanism he would make hæmoglobin *F* ($\alpha_2^A\gamma_2^F$), which has γ chains instead of β chains Alternatively, the genotype might be α^X/α^A, β^A/β^S if the subject has an α chain thalassæmia In this case, synthesis of apparently normal hæmoglobin *A*, which is really $\alpha_2^X\beta_2^A$, might go on to a small extent in addition to production of hæmoglobin *A*, depending on the severity of the mutation Also the degree to which increased production of hæmoglobin *F* is allowed or required might be expected to be very different in this second case, assuming a common α gene for hæmoglobins *A* and *F*

If the same α gene controls the production of the α chains of hæmoglobin *F* and the α chains of hæmoglobin *A*, then individuals homozygous for severe α thalassæmias should not be found *In utero* they would have very low levels of hæmoglobin *F*, which would most likely prove fatal in the absence of any compensatory effect This conclusion implies that all patients with thalassæmia major are either homozygous for a β-chain defect, which would not interfere with the production of fœtal hæmoglobin, or that they are doubly heterozygous for α- and β-chain defects, or else that they have a defect of a different type

If it should be the case that Kunkel's hæmoglobin A_2 also has α chains, which are similar to those of hæmoglobins *A* and *F*, and if all these α chains are controlled by one and the same 'α gene', then the two types of thalassæmia would be expected to differ in the extent to which the A_2-level should be affected A β chain mutation would allow an increase in A_2 to occur, whereas an α chain mutation would not Such differences in the level of A_2 in different thalassæmias are known to exist Nevertheless it would probably be unwise to throw out entirely the notion that thalassæmia can act as a general suppressor of hæmoglobin synthesis The disease exists in so many varied forms that some of them may be of this type We are postulating that the majority of thalassæmias fall into the class described by the 'substitution' hypothesis

Application of the Hypothesis

Silvestroni and Bianco[25] describe two families including a member having 'microdrepanocytic disease'—or sickle cell-thalassæmia disease (see Fig 2)

The genotypes were deduced from hæmatological examinations, details are not given in the paper, so the phenotypic expression of the thalassæmia gene in the thalassæmia minor cases is not known, the proportions of different types of hæmoglobin were not measured We notice two marriages involving a person heterozygous for both thalassæmia and sickle cell trait In one case ('family 6', Fig 2), such a man when married to a normal woman has a doubly heterozygous child, and in the other case ('family 9', Fig 2) when married to a woman with thalassæmia minor has a normal child The S change is known to occur on the β chain of hæmoglobin[21,23] and we assume this to be a case of the same hæmoglobin S These patterns of inheritance and the other statistics presented by the authors suggest that the gene for thalassæmia and the gene for sickle cell anæmia in these double heterozygotes are non-allelic and the pattern of inheritance can be explained as follows by assuming the thalassæmia to be of the α variety (Fig 3) Since we cannot deduce whether the mother of 'family 9', who has thalassæmia minor, has an α or a β thalassæmia, the child with thalassæmia major in this family could either have two α gene defects, or an α and a β defect If the genes produce the appropriate chains independently, we would expect the double heterozygotes α^X/α^A, β^A/β^S to produce hæmoglobin A in addition to S The reported data are not sufficient to corroborate this deduction

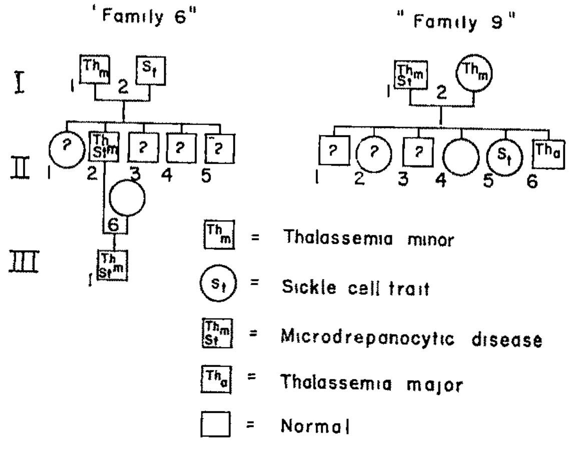

Fig 2 Phenotypes of the living members of two of the families studied by Silvestroni and Bianco (ref 25)

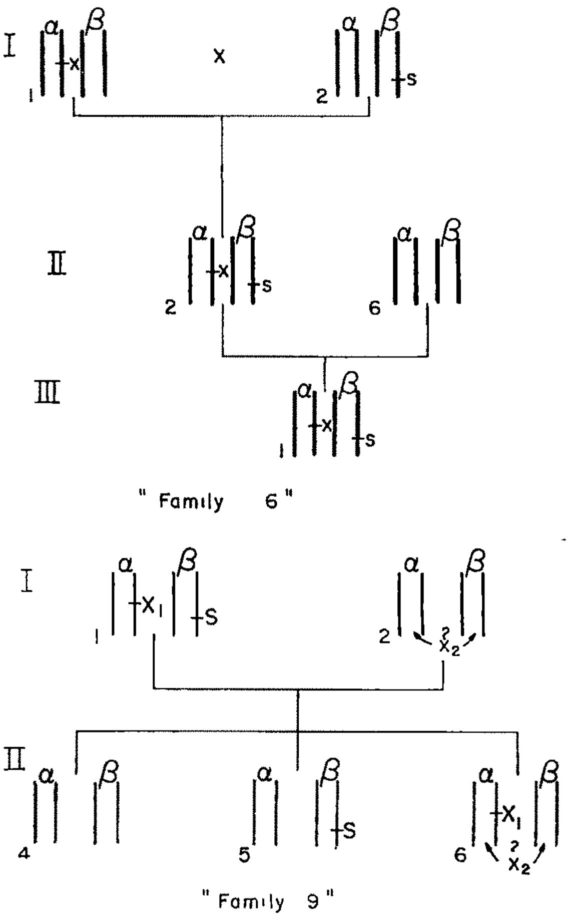

Fig 3 Genotypes of the families shown in Fig 2, but including only individuals with known phenotypes The vertical lines represent the α and β hæmoglobin genes as marked + S denotes the sickle cell mutation, and + X the thalassæmia mutations

Neel[26] described a family where a normal person and a person who appears to be heterozygous for both sickle cell anæmia and thalassæmia have two apparently normal children, one child and possibly a second with thalassæmia minor, one and possibly a second with sickle cell-thalassæmia disease, and one child with sickle cell trait In order to explain this in terms of the two hæmoglobin genes, the thalassæmia defects must in this case be on the α gene, this family, 'kindred 60' (Fig. 4), provides evidence for the idea that this thalassæmia is on the α gene, while the hæmoglobin S mutation is on the β gene The last series for sickle cell-thalassæmia disease are three families described by Ceppellini[27], where the children of a normal person married to a person with sickle cell-thalassæmia disease are either thalassæmic or have sickle cell trait In one family of seven, three children have sickle cell trait and four have thalassæmia minor, while the other two families include three children each, and in both cases two have sickle cell trait and one has thalassæmia minor In these three families involving thirteen children, six have thalassæmia minor and seven have sickle cell trait, which suggests that the thalassæmia defect is in these cases on the hæmoglobin β gene, like hæmoglobin S, since all the children inherit either sickle cell trait or thalassæmia minor, with equal probability; it is, of course, impossible to reach definite conclusions using such small numbers The critical family of Schwartz *et al* [19], which includes cases of hæmoglobin *S* and *G* as well as thalassæmia, is under re-evaluation and will not be discussed here

Hœmoglobin H It was recently reported[28] that hæmoglobin *H* is composed of four polypeptide chains, but that these are all of the β variety This agrees well with the physical behaviour and the instability of this hæmoglobin

According to Motulsky[29], such cases occur together with thalassæmia minor in the family, and therefore it was postulated that "hæmoglobin *H* is only shown electrophoretically in the presence of thalassæmia" On the other hand, Bingle *et al* [30] have reported hæmoglobin *H* without apparent thalassæmia

Taking the first cases, two explanations are possible If it is true that the β chains of which hæmoglobin *H* is composed are in every detail normal, then we may postulate that hæmoglobin *H* occurs where two mild α thalassæmias occur together (Fig 5*b*) One of these might be so mild as to be not noticeable until together with the other The genotype $\alpha^{X_1}/\alpha^{X_2}\ \beta^A/\beta^A$ would manufacture a large excess of β chains which complex to form $\beta_4{}^A$ = hæmoglobin *H* In Fig 5*a* the person III 1 shows hæmoglobin *H* and II 3 and III 4 show thalassæmia In the alternative explanation, the hæmoglobin *H* β chains might have a non-electrophoretic change such that production of this chain is increased or such that when the proportion is increased due to an α thalassæmia, the β^H chains polymerize preferentially In this case the genetic picture would be as shown in Fig 5*c*

In two families described by Fessas[32], hæmoglobin *H* is transmitted from father to son, showing that the genes for hæmoglobin *H* and thalassæmia cannot be allelic, since they are both inherited from one parent In these cases, the second explanation, namely, that a non-electrophoretic change in the β chain allows a preferential polymerization of excess β chains, must be preferred

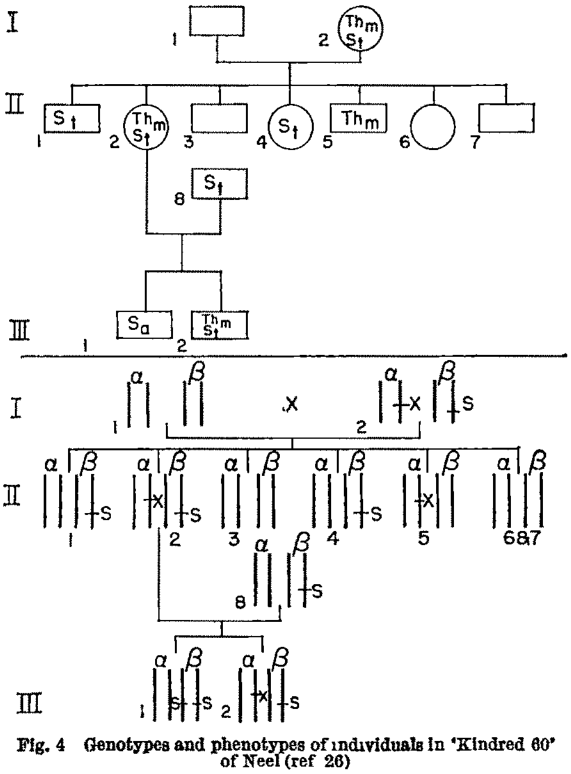

Fig. 4 Genotypes and phenotypes of individuals in 'Kindred 60' of Neel (ref 26)

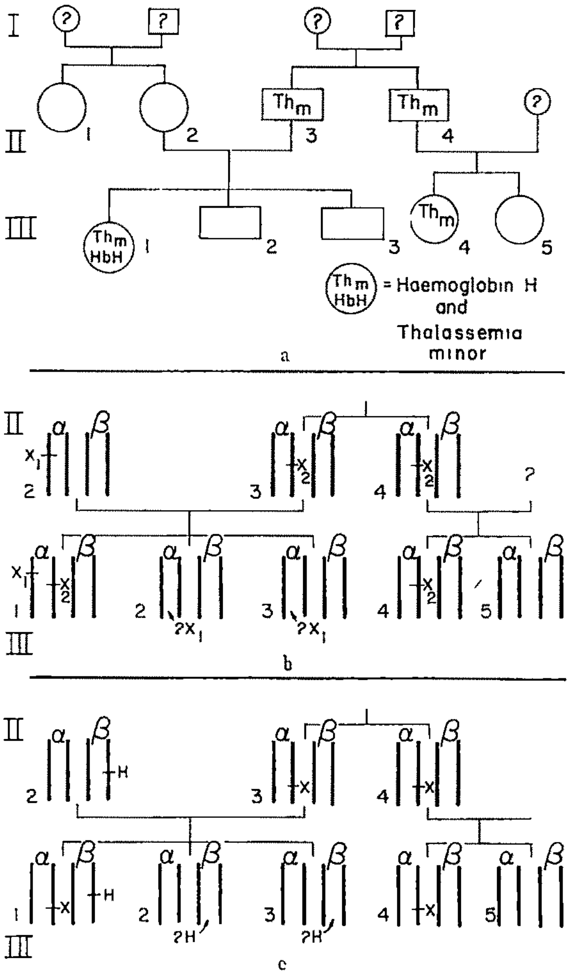

Fig 5 Family described by Gerald (ref 31) illustrating the inheritance of hæmoglobin *H* *a* = phenotypes, *b* and *c* = the two patterns of inheritance discussed in the text

It might equally be expected that a hæmoglobin composed of four α chains could be produced in circumstances similar to those leading to formation of hæmoglobin *H*, namely, the presence of two mild thalassæmia genes affecting the rate of synthesis of β chains, thus

$$\alpha^A/\alpha^A,\ \beta^{X_1}/\beta^{X_2} \rightarrow \alpha_2{}^A\beta_2{}^{X_1} + \alpha_2{}^A\beta_2{}^{X_2} + \alpha_4{}^A$$

Alternatively, an altered α gene might produce an α chain which could polymerize to give $\alpha_4{}^A$, if α chains tend to be produced in excess due to thalassæmia

Discussion

Consideration of the families of patients with sickle cell-thalassæmia disease in terms of the hypothesis that the hæmoglobin gene is really two genes has led us to conclude that the thalassæmia defect, producing a hæmoglobin having the same electrophoretic mobility as normal hæmoglobin, but at a reduced rate, may in some cases be located on the hæmoglobin β gene (Fig 6, case 1), and in other cases is on the hæmoglobin α gene (Fig. 6, case 2)

In case 1, since both copies of the hæmoglobin β gene are altered, one copy producing an electrophoretically distinct polypeptide chain, and the other

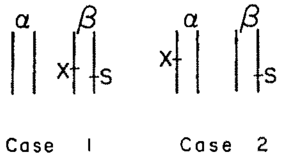

Fig. 6. The two possible genotypes to be expected in sickle cell-thalassæmia disease

producing a pseudo-normal chain but at a greatly reduced rate, it might be expected that the proportion of hæmoglobin S to 'normal' hæmoglobin should be higher than in the case of sickle cell trait; this is observed in most cases.

In case 2, however, one copy of the hæmoglobin α gene and one copy of the hæmoglobin β gene are quite unchanged, so the proportion of hæmoglobin A would be expected to be higher than that of hæmoglobin S, if $(\beta^A)_2$ is produced at a higher rate than $(\beta^S)_2$ as we have supposed. It is significant that in the case of Neel's family (kindred 60) where the genotype can be deduced to be type 2, the proportion of hæmoglobin S, as determined by later analyses, is 22, 28 and 36 per cent in three individuals, in contrast to 60–80 per cent found in other cases of sickle cell-thalassæmia disease[34]; further data on this point are needed. Furthermore, re-examination of this family[33] (kindred 60) has shown that the A_2-level was not elevated in individuals where the presence of a thalassæmia gene has been deduced. If A_2 has an α chain and the α gene responsible for its production is identical to that of hæmoglobin A, such an α thalassæmia would not be expected to allow the proportion of A_2 to rise, whereas a β thalassæmia, while decreasing the rate of synthesis of hæmoglobin A by lowering the rate of synthesis of β chains, should allow the level of A_2 to rise, if the α chains only are common.

In this connexion it is interesting to note that in two cases of thalassæmia-hæmoglobin C disease, where the genetic data are insufficient to establish the probable genotype, in one family hæmoglobin C is present to the extent of 74–77 per cent[35], while in the other family it comprises only 29 per cent[36] of the total hæmoglobin. This difference in interaction of the two genes may be due to the presence of different thalassæmia genes in each case, one on the hæmoglobin β gene and the other on the hæmoglobin α gene, respectively, as postulated for different cases of sickle cell-thalassæmia disease.

Further examination[37] of the second family in the previous paragraph, where the thalassæmia is of the 'non-interacting' kind, showed that the parent from whom the thalassæmia gene was transmitted did not have an elevation of A_2. This was also true of other children of the same parent, who also showed all the other characteristics of thalassæmia minor. On the other hand, persons with thalassæmia minor in the first family, with the 'interacting' type of thalassæmia, showed in the original electrophoretic patterns an 'unidentified component', later identified as hæmoglobin A_2 (ref. 38) at levels of 6–7 per cent.

It would be interesting to investigate the proportion of hæmoglobin A_2 in individuals with thalassæmia minor in these families where different sorts of genotypes are proposed. In many cases of thalassæmia minor, the level of A_2 is roughly doubled, as is usually the case with the level of abnormal hæmoglobin in double heterozygotes; it is possible that α and β thalassæmias may differ by allowing or not allowing the proportion of A_2 to rise in compensation.

In this connexion the findings of Kunkel *et al.*[7] where parents of children with thalassæmia major were found having A_2-levels within the normal range are very interesting.

It is also important to remember that cases of parents of children with thalassæmia major have been found who carry none of the characteristics of thalassæmia minor, so apparently normal people may, in fact, carry a thalassæmia gene[6,39].

This hypothesis as to the possible genetic and molecular mechanism involved in thalassæmia is open to experimental test; it would predict that in cases of thalassæmia major the hæmoglobin having the same mobility as hæmoglobin A has a different amino-acid sequence, possibly bearing the same relationship to normal hæmoglobin as do the established 'abnormal' hæmoglobins that have been studied in detail; namely, a difference in one amino-acid. Such a difference might be detected by analysis of the amino-acid composition of peptides of hæmoglobin A from normal and thalassæmia major subjects.

It may be that the wide variability in expression of thalassæmia is due to the possibility of the simultaneous presence of different types of genetic defect. For example, the genotypes α^{X_1}/α^A, β^A/β^{X_2} and $\alpha^{X_1}/\alpha^{X_2}$, β^A/β^A might lead to different phenotypic expressions and to different severity of the disease. Bearing in mind the further possibility of a defect in hæm synthesis, or other abnormalities, a wide spectrum of clinical states might be expected.

An Alternative: the 'Tap' Hypothesis

Freese[40] put forward the concept of chromosome structure in which genetically significant deoxyribonucleic acid alternates in a linear arrangement with 'connecting units'. Based on this idea, we can construct a second hypothesis to explain the occurrence of thalassæmias. Freese's 'connecting units' could be made of protein or of deoxyribonucleic acid and the structure of these units, if protein, could be determined by a small part of an adjacent deoxyribonucleic acid template. It might be further assumed that these connecting units serve to activate or inactivate the genetic deoxyribonucleic acid which follows them. In the case of the β chain gene, it might happen that a defect in the connecting unit preceding it results in this gene remaining silent. Therefore, β chains are not made and a β chain thalassæmia results with its deficiency in hæmoglobin. Such a defect would be genetically controlled by an adjacent region of deoxyribonucleic acid, sufficiently close to the β chain gene to be indistinguishable by the presently available data in human genetics. A similar picture would hold in the case of α chain thalassæmias. The defect in activating the α or β chain genes might be expected to range from zero to complete shut off, producing a number of intermediate steps. This explanation in which the 'tap' is turned off differs fundamentally from the one presented in the previous sections, because here the α or β chain genes are assumed to be perfectly normal. It is merely the degree to which they are activated that is affected. When, under the 'tap' hypothesis, a chain is made at all, its amino-acid sequence would be normal, even if it is made more slowly. On the previous hypothesis, the 'substitution' hypothesis, the chain when made is expected to carry one or more amino-acid substitutions or deletions. The genetic analysis presented in the preceding section is valid in terms of both hypotheses since the gene and its 'tap' would be very closely linked We have chosen to develop the 'substitution' hypothesis in greater detail because it is based on fewer assumptions than the 'tap' hypothesis

Summary

We propose that thalassæmia is a mutation of either the α or the β hæmoglobin gene, of the same kind as that observed in the abnormal adult hæmoglobins, but without effect on the electrophoretic behaviour of the protein Such mutations would be expected to reduce, sometimes to nothing, the rate of production of that hæmoglobin

We are grateful to Dr Park Gerald, Boston, and Dr H Lehmann, London, for the help of many stimulating discussions We wish to express our thanks to the Medical Foundation, Inc , Boston, for a grant, and to the National Institutes of Health for a fellowship (A O W S)

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INTERNATIONAL MINERALOGICAL ASSOCIATION

FIRST GENERAL MEETING

MINERALOGISTS from nineteen countries assembled in Zurich at the end of August to attend the first meeting of the International Mineralogical Association and afterwards to go on one of the two field excursions Many of those present had also attended the foundation meeting of the Association at Madrid in April 1958 There it had been laid down that the Association shall be an association of national mineralogical societies and pursue the aim of furthering the cause of mineralogy in all its aspects To effect this, technical problems confronting mineralogists will be dealt with by special commissions, while scientific matters will be treated in symposia and eventually in publications sponsored by the Association The commissions (at present numbering four) proceeded to deal with questions relating to abstracts, new minerals, mineral data and museums, while at business meetings the statutes of the Association came up for discussion and amendment Two symposia were held of which a brief account will be given here The papers will be printed *in extenso* in a coming volume of the *Estudios Geologicos* published by the Instituto "Lucas Mallada" in Madrid

Alpine Mineral Fissures

The first symposium, held under the chairmanship of Prof E Wenk (Basle), dealt with Alpine mineral fissures To these may be assigned numerous occurrences in Switzerland and also some in quite different regions Prof R L Parker (Zurich) outlined the main features of these deposits as shown by the Swiss localities Though deservedly called "Alpine", the distribution in the Alps of such occurrences is localized and restricted to areas in which the interplay of mechanical forces and strength properties of the rocks is suitably balanced The resulting fissures are late- to post-tectonic in formation and filling and show no prolongation in depth They contain varied mineral assemblages which are considered to have crystallized from solutions deriving their contents from the surrounding rocks The belief that this process (known as lateral secretion) was widespread in the Alps is supported by the quite general dependence of the fissure contents on the character of the country rock and frequently also by the presence around fissures of a zone of leached rock which seems to have been the source of the matter now contained in the crystallized minerals of the fissure Among these, quartz and adularia are practically ubiquitous

The relationship of Alpine fissure minerals to those of the druses in the granite of Baveno was discussed by Prof G Fagnani (Milan) That such a comparison may be made is shown by the numerous minerals common to both types of occurrence These include not only widespread species such as quartz and orthoclase but scarcer ones also, and even some like gadolinite and bazzite that are rarities in central Europe. In spite of such similarities, the Alpine fissures and the Baveno geodes actually have little in common. Even the minerals occurring in both show differences in habit which reflect the differing modes of formation. This is especially true of orthoclase, which in the Alpine fissures is always developed as adularia which never appears at Baveno. The Baveno quartz, though well crystallized, lacks the wealth of forms prevalent in the fissures and never shows the Ticino habit with large acute rhombohedra found in some Swiss occurrences. A significant paragenetic detail is the appearance of zinnwaldite instead of muscovite as chief mica of the geodes.

Dealing with the origin of quartz as a fissure mineral of the Alpine type in the U.S.S.R., Prof. D. P. Grigoriev (Leningrad) stated that numerous mineral occurrences in the Soviet Union are assigned to the Alpine type of fissure deposit. A reason for doing so is the possibility of establishing definite connexions between the country rock and the mineral parageneses found in the veins and cavities in question. Analytical results obtained on unaltered country rock and on altered specimens from the veins provide corroborative evidence. As a special instance of Alpine-type mineral genesis, Prof. Grigoriev discussed the derivation and crystallization of quartz found in veins which are younger than the quartzite rocks in which they occur. Many of the observed peculiarities of Alpine quartz relating to crystal habit, distortion, aggregate development, distribution, etc., have been traced to and explained by such factors as the number, distribution, and exposure of seed crystals, and the physical state of the circulating solutions, which may be saturated in respect to the large seed crystals of quartz while still unsaturated as regards the small ones. The relative rates of crystallization of different minerals were also discussed and prove to be characteristic for a given locality though varying strongly from place to place.

Prof. M. A. Kashkai (Baku) showed that in the Caucasus Mountains (which possess many points of similarity to the Alps) mineral deposits frequently occur which, judged by the applicable criteria, must be considered to be of a nature and formed by processes akin to those of the Alpine fissures. Emphasis was laid on the wide distribution of so-called 'listvenites', which are metamorphic rocks consisting chiefly of quartz, carbonates, and chlorite besides numerous accessory constituents. As these are sometimes formed from hydrothermal solutions, relationships between them and deposits of Alpine type can be established.

Prof. J. Lietz (Hamburg) described experiments he has carried out on small cubes of colourless quartz designed to convert them into smoky quartz by electrolysis. The cubes are placed between electrodes and treated in an electric field of 200–1,500 V./cm. at temperatures of 700°–900° C. The arrangement of the electrodes fundamentally affects the results obtained. When the crystallographic axis of the crystal lies in the direction of the field and each electrode completely covers one side of the cube, a front of colour appears at the anode and migrates towards the cathode, thus progressively filling the entire cube. However, when the front has reached the cathode, the cube starts losing colour at the anode and finally becomes colourless again. When the anode only partially covers one side of the cube, the portion of the latter lying immediately in front of the anode is coloured and discoloured as just described, whereas that part of the cube not covered by the anode also assumes an intense dark colour which does not disappear and proves to be thermally stable up to 1,000° C. The phenomena agree well with the assumption that colour centres exist in the quartz lattice in the form of ($AlO_{4/2}$) tetrahedra which yield an electron when electrolysed.

Prof. F. Laves (Zurich) spoke on the feldspars of the Alpine fissures and their twinning. While the twins of adularia (potassium-feldspar with up to 10 per cent sodium) consist of a restricted number of individuals, albite (translucent sodium-feldspar) tends towards polysynthetic twins comprising many individuals. Such twinning may be the result of diffusive changes in the distribution of aluminium and silicon in the lattice or of displacive transformations due to a temperature-conditioned collapse of the structure. However, polysynthetic twins sometimes result from mechanical deformation when the distribution of aluminium and silicon is sufficiently disordered. The more opaque milky white variety of albite elongated after the *b*-axis and known as pericline is twinned according to a law usually defined as a rotation of 180° about the *b*-axis. Investigations show, however, that structural changes must have taken place after twin formation and be the reason why the inter-relation between the crystals only approximates to this law, the 'twin axis' being actually an irrational direction in (001). Leaching of a primary anorthite content and its partial metasomatic replacement by albite substance is a reason for this condition and causes numerous minute voids within the crystals. This accounts for their milky appearance.

Twinning of Crystals

The second symposium, the chairman of which was Prof. Martin J. Buerger (Cambridge, Mass.), had as its topic the twinning of crystals. Prof. Buerger's own paper was devoted to various aspects of twinning in general but with special regard to the boundaries between the twinned individuals. While the low energy of such junctions is quite generally a most characteristic feature of twins, the latter may be connected either by coherent or incoherent boundaries. A common type of coherent twin results from simple or more general stacking faults in the structure. Ex-solution pairs, however, always have incoherent boundaries. According to Prof. Buerger, twins related by 3-fold, 4-fold and 6-fold rotations are certainly possible.

Dr. H. Curien (Paris), discussing the degree of symmetry which a twin axis may possess, recalled the belief held by Georges Friedel that twin axes may be of a 2-, 3-, 4-, or 6-fold character. Examining each of these possibilities, Dr. Curien considers unlikely those involving 3- or 6-fold rotations, for these could not bring about any strict coincidence of lattice planes belonging to the two participating crystals. An example believed by Friedel to exemplify twinning by such an operation is the sagenite twin of rutile in which three crystals seemingly occupy positions realizable by a 60° rotation around the *a*-axis. However, this grouping can be accounted for by supposing the well-known twin laws of rutile (reflexion on (011) and (031)) to be both operative. They lead to positions deviating by only 10′, that is, by an amount within the experimental error, from the theoretical hexagonal positions. Dr. Curien accepts the possibility of twinning according to 4-fold axes

These will be oriented along lines of intersection between perpendicular planes present in all systems except the triclinic Such axes will, however, not produce actual coincidence of the nodes of the lattice planes, so that the 'quality' of such twins must be much inferior to that of ordinary ones

Prof J D H Donnay (Baltimore) proceeded from the fact established by Georges Friedel that a crystal twins whenever there is a superlattice that has (rigorously or approximately) more symmetry than the actual lattice of the crystal Similarly, it seems that the presence of an appropriate sub-lattice may lead to twinning It was then shown that twinning may also be explained in terms of the 'lattice complex' of Paul Niggli This term is applied to the assemblage of all like atoms in a structure independently of its position in the space group When such a complex of atoms has more symmetry than the space group as a whole, the remaining atoms can distribute themselves in various ways which are related by symmetry operations belonging to the complex but not to the space group These are the operations by which certain types of twinning are achieved

Dr P Hartman (Groningen) spoke on the twin of atacamite, the law of which is definable either as a 120° rotation about the [950] direction or as one of 180° about [544] The structural explanation lies, according to Dr Hartman, in the parallelism of chain links in the structure and not of lattice rows as in ordinary twins This, however, recalls the manner in which crystals of different species sometimes grow together in oriented pairs This phenomenon is known as epitaxy, and Dr Hartman suggested that very close relationships exist between it and twinning This would imply the non-existence of 3-, 4-, and 6-fold twin axes

Dr W T Holser (La Habra, Cal) analysed the relations of symmetry and structure at the boundary plane of a twin, extending his investigation to include trans-boundary relations He re-described Buerger's model of a trans-boundary growth step as a particular type of screw dislocation Twin stability is related to some measure of fit along the dislocation of the step, which latter may be symmetrical or pseudo-symmetrical

Prof T Ito (Tokyo) spoke on twinning as a building principle of crystals and introduced the new concept of 'space groupoids' as distinct from space groups

Dealing with twinning in diamond, Prof A Neuhaus (Bonn) first summarized some of the conflicting observations made on this mineral As a result of his own investigations, he considers it certain that a transition between two modifications takes place but believes that only one is isometric He assigns this one (α-diamond) to the O_h crystal class while attributing rhombohedral (D_{3d}–) symmetry of pseudo-isometric character to the other (β-diamond) Coarsely lamellated diamond seems to have evolved by natural tempering from such material showing finer alternations and arising from the transformation of the original isotropic substance Thus a distinction must be made between the true double-refraction of β-diamond and irregular effects due to strains produced by (sub-) microscopic inclusions Primary α-diamond is stable at high pressures and temperatures above 1,500° K , whereas β-diamond is stable at lower temperatures Natural diamonds always belong to the β-modification and may either have been formed as such from the outset or be the result of a secondary α-β transformation In either case twin lamellæ will be present which are primary in one and secondary (mimetic) in the other Prof Neuhaus demonstrated a new phase diagram of carbon from which conclusions regarding the stable formation of diamond can be drawn and the differences between Type-1 and II diamonds explained

Dr I Sunagawa (Tokyo) described the growth and natural etch patterns observed with a phase-contrast microscope on the boundaries of hematite crystals forming contact twins after $(10\bar{1}0)$ The surface structures of the twin boundaries are difficult to explain as simple junctions in twin position effected during growth It seems, rather, that the mechanism of contact twinning involves processes of faulting or slipping of the participating lattices

ROBERT L PARKER

SCHOOL OF PHYSICS WITHIN THE UNIVERSITY OF SYDNEY

THE research activities and student numbers of the School of Physics within the University of Sydney, the head of which is Prof H Messel, have expanded so much during the past six years that a major reorganization has become necessary

Henceforth there will be five departments within the School , the newly created departments are (1) The Basser Computing Department , (2) The Daily Telegraph Theoretical Department , (3) The Falkiner Nuclear Department , (4) The Wills Thermonuclear Department , (5) The Chatterton Astronomy Department

The Basser Computing Department arises from the Adolph Basser Computing Laboratory with the electronic digital computer, *Silliac* I This computer has been a great success in Australia and largely responsible for opening up the computing field there Opened on July 1, 1956, *Silliac* I has run at high reliability since that date, and at present is occupied 24 hr a day on a three-shift basis Work has or is being carried out for every University in Australia, two in New Zealand, for 20 government and semi-government organizations and 87 private organizations Some two hundred personnel throughout the country have attended courses on the computer and a postgraduate diploma course in automatic computing has been established

Steps are now being taken to proceed with the construction of a much faster transistorized machine. *Silliac* I was constructed using the University of Illinois design of *Illiac* The new computer in the Basser Department is likely to use the design of the new fast computer at present being built by the Illinois group The present cost is estimated at £A 575,000 These funds have still to be provided

Dr John M Bennett is in charge of numerical analysis and the user end of *Silliac* I, while Mr B E. Swire is chief engineer

The Daily Telegraph Theoretical Department was established with a gift of £A 50,000 from Consolidated Press, Ltd The theoretical group which forms the basis of the newly created department always has been a strong one The appointment of Prof S T Butler to the chair of theoretical physics should do much to enhance the position of the Department Work in the Department is centred on nuclear, solid-state, low-temperature, shower and field theory

An original gift of £A 50,000 by Dr G B S Falkiner was used to establish the F B S Falkiner Nuclear Research Laboratory in memory of his father This Laboratory, with twenty scientists, has been working during the past six years on various aspects of cosmic radiation and forms the basis of the new department At present there are two large groups One is specializing in the use of nuclear emulsions for the study of the primary cosmic radiation and high-energy jets, the second group is concerned with a large-scale study of extensive air showers

Considerable expansion of the efforts within the Department have taken place since the appointment of Prof C B A McCusker as leader of the cosmic-ray team of workers Further expansion in the work of both the emulsion and extensive air shower groups is taking place at present

The equipment from the large Culham air shower experiment which was run by the Harwell group in England arrived in Australia earlier during the year and has now been integrated into the former air shower experiment in Sydney The American Air Force in Texas has recently flown £5,000's worth of nuclear emulsion for the emulsion group to a height of 126,000 ft Balloons of 3,000,000 cu ft capacity were used The flights were made gratis The emulsion is to be processed in Chicago using the large developing facilities available in Prof Marcel Schein's group

The Wills Thermonuclear Department is a new one and has been made possible by a gift of £A 50,000 from W D and H O Wills (Australia) Ltd in Sydney The gift will be used for providing some of the initial research equipment required by the Department The creation of a thermonuclear department in the School is in keeping with recent developments overseas in the thermonuclear field, where there has been a marked tendency for the research effort to swing back from large-scale engineering attacks to work of a more fundamental nature and on a smaller scale It will also allow Australia to partake from an early stage in this exciting field of research

The appointment of Prof C N Watson Munro, chief scientist of the Australian Atomic Energy Commission, to the chair of thermonuclear physics is in keeping with his experience in the nuclear field He was one of the pioneers in the nuclear reactor field and it is his wish now to try to pioneer some of the work in the thermonuclear field

The Chatterton Astronomy Department will have two groups One group will use a 40-in reflecting telescope with auxiliary photoelectric equipment to consider problems in astronomy, the interpretation of which relies heavily upon physics The contract for the instrument will be placed during 1960 and the instrument should be installed during 1961 Total initial cost of the project will be around £A 100,000 The site for the instrument has still to be determined, but is highly likely to be situated at a joint Mount Stromlo–Sydney School of Physics field station A survey for the site is at present being carried out by the Mount Stromlo group

The second group will in the first instance be concerned with work using an intensity interferometer (at a later date a general interferometry group will be built up) This instrument, the first of its kind to be built, is based upon the work of two British scientists, Mr Hanbury Brown of the University of Manchester and Dr R Q Twiss, who is a member of staff of the Chatterton Astronomy Department The instrument will be used for measuring the temperature and diameter of stars—both very important quantities in astrophysics

The contract for the instrument has been let in England and the interferometer will arrive in Australia towards the end of 1960 The site for the field station at which the instrument will be erected is likely to be at Narrabri, New South Wales—about 370 miles north-west of Sydney Initial cost of the project will be in the neighbourhood of £A 175,000 Initial funds for work in the Astronomy Department were provided by a grant of £A 50,000 from Mr Stan Chatterton, a prominent member of the Nuclear Research Foundation within the University of Sydney

It will be noted that the five new departments within the School of Physics form an integrated research effort The work of all the departments is closely linked and has been chosen with that purpose in mind It should allow Australia to make an ever-increasing contribution to furthering new knowledge in these fields

The Nuclear Research Foundation within the University of Sydney has been responsible for the provision of the major funds for the research effort in the School of Physics A sum approaching £A 1,000,000 has been raised in various ways during the past six years

OBITUARY

Dr H H Potter

THE death is announced of Dr Harold Herbert Potter, lecturer in physics in the University of Bristol from 1924 until his retirement last summer owing to ill-health Dr Potter was a graduate of Bristol, who spent four years at King's College, London, as the holder of an 1851 Exhibition before returning to Bristol At King's College, under O W Richardson, he carried out accurate measurements on the proportionality between mass and weight, and showed that the ratio is independent of the nature of the material within an experimental error of fifteen parts in a million

To workers in the field of magnetism, Potter was well known for his investigations in Bristol in the field of ferromagnetics, both in collaboration with Sucksmith and independently between the two World Wars This work included specific heat measurements through the Curie point, the magnetic properties of single crystals and their correlation with crystal structure, including Heusler and other magnetic alloys, and the electrical resistivity of nickel and iron from 20° to 1,200° K

As an experimenter, Potter's work was careful, reliable and important in its period, it will also stand the test of time In addition, he was a keen, effective and popular teacher of undergraduates

He leaves a widow but no children

NEWS and VIEWS

Chemistry at Bedford College, London.

Prof. E. E Turner, F R S

THE retirement is announced of Prof E E Turner, head of the Department of Chemistry at Bedford College, University of London Prof Turner received his early education in the Coopers' Company School, in Queen Mary College, and in Sidney Sussex College He was assistant (chemical warfare research) to Sir William Pope, and he also served in the Research Department, Royal Arsenal, Woolwich His first teaching appointments were in the University of Sydney and in Queen Mary College Later, he was reader (1928–44) and professor (since 1944) at Bedford College, University of London He is a Fellow of Queen Mary College, Freeman of the City of London, and Liveryman of the Coopers Company He was elected to the fellowship of the Royal Society in 1939 Prof Turner has made most distinguished contributions to research in organic chemistry, including especially stereochemical problems, such as molecular dissymmetry dependent on restricted rotation about a single bond in diphenyl and other compounds, asymmetric synthesis and transformation He is joint author (with Margaret M Harris) of a well-known text-book of organic chemistry Prof Turner's services to chemistry in many fields are far too numerous to mention, to give but one example, his colleagues in the University of London recall with pleasure and gratitude his many years of service on the Board of Studies in Chemistry, first as secretary and later as chairman

Prof P. B D de la Mare

DR P B D DE LA MARE, who is to succeed Prof Turner, was educated at the Hamilton High School and Victoria University College, New Zealand His interest and flair for research in physical–organic chemistry was first shown in important papers, in collaboration with Prof P W Robertson, on the addition of halogens to olefins Following his degree work at Wellington, he was directed for national service to the New Zealand Government Department of Agriculture, where he worked on problems of nutrition and the chemistry of lipids with Dr F B Shorland During 1946–48 he held a University of New Zealand fellowship at University College, London, and he was awarded the Ramsay Memorial Medal in 1948 Since that time he has been a member of staff of University College, where he is at present a reader in chemistry He has made most notable contributions to the study of addition, substitution and re-arrangement processes in organic chemistry He is a co-editor, with Dr W Klyne, of "Progress in Stereochemistry", vol 2, and a co-author, with Dr J H Ridd, of "Aromatic Substitution—Nitration and Halogenation" He is a member of the Publications Committee of the Chemical Society and of the Joint Library Committee It is evident that the established traditions at Bedford College will continue to grow under Dr de la Mare's direction

Pierre Joseph van Beneden (1809–94)

THE distinguished Belgian zoologist, parasitologist and palæontologist, Pierre Joseph van Beneden, was born at Malines 150 years ago on December 19, 1809 After graduating M D at Louvain, he abandoned medical practice for natural history, but all his life maintained a keen interest in those branches of medicine which are aided by the study of the lower organisms In 1831 he was appointed conservator of the Natural History Museum in Louvain, and in 1835 professor of zoology at the University of Ghent In the following year he was elected to the corresponding chair at Louvain, which he occupied until his death In 1843 he established at his own expense one of the earliest laboratories of marine zoology and aquaria Author of some 200 brochures, his best-known works are "Zoologie Médicale" (1859) and "Ostéographie des Cétacées Vivants et Fossiles" (1868–80), both written in co-operation with Paul Gervais, and "Les Commensaux et les Parasites dans le Règne Animal" (1875, English translation, "Animal Parasites and Messmates", 4th ed, 1889) He made original contributions to scientific knowledge of the development of polypi and of worms, both intestinal and vesical, was the first to distinguish between 'commensalisme' and 'mutualisme', and enriched the catalogue of cetaceous fossils by several new species Recipient of many honours, he was a foreign member of the Royal Society and of the Linnæan, Geological and Zoological Societies of London, and in 1881 served as president of the Royal Belgian Academy In 1886 he was created Grand Officer of the Order of Leopold A modest and kindly man, he died at Louvain on January 8, 1894 His fame has been eclipsed by that of his son, Édouard van Beneden (1846–1910), the embryologist

Astronomy for the Layman

IN a series of articles in the *Illustrated London News* early in 1959, Dr R A Lyttleton described the astronomical universe starting at the Earth and working outwards These articles proved of great interest, and consequently the *Illustrated London News* is publishing a second series of astronomical articles, this time they are written by Prof H Bondi, of King's College, London The first appeared on October 31, and the remaining eleven articles are following at weekly intervals As before, the articles are accompanied by photographs and by illustrations drawn by Mr G H Davis, the special artist of the *Illustrated London News* Prof Bondi started with the most distant objects observed, and will work inwards in later articles After some preliminary remarks on the philosophical basis of science he discusses the expansion of the universe His second article discusses the famous paradox of Olbers (Why is it dark at night?), and this is followed in the third and fourth articles by an account of the evolutionary and steady-state theories of cosmology and of possible observational tests of these theories In subsequent articles Prof Bondi will discuss the stars, interstellar and interplanetary space and gravitational problems in the solar system, ending with the motion and magnetism of the Earth

Management in India

IN her five-year plan, India is trying democratically to meet the desperate needs of her peoples for better living conditions Industrialization is proceeding rapidly, and it is encouraging to read how leaders of industry in India are not only trying to avoid the mistakes made by Western countries during their industrial revolution but are also seeking to utilize the best practices of the best industrial organizations in Western countries. The Ahmedabad Textile Industry's Research Association has attracted interest for the attention it is paying to the industrial application of research, the use of work study, and the training of technologists and technicians. Its latest venture is the holding of a conference deriving its inspiration from H.R.H. the Duke of Edinburgh's Study Conference on the Human Problems of Industrial Communities within the Commonwealth and Empire. Many of the subjects selected for study were the same as those arranged at the Duke of Edinburgh's conference at Oxford. It was particularly appropriate that the Duke was able to open the conference, while another distinguished speaker was Sir Alexander Fleck. The proceedings of the Conference (Ahmedabad Textile Industry's Research Association. Proceedings of the Fifth Management Conference, January 28, 29 and 30, 1959. Pp. ix+93. Ahmedabad: Ahmedabad Textile Industry's Research Association, 1959) have now been published.

A Giant Plesiosaur

About sixty years ago a fossilized piece of the mandible of a large skull, with three broken teeth preserved on each side, was found in rocks of the Lower Cretaceous near Hughenden, Queensland. The specimen, which is in the collection of the Queensland Museum, is about 8 in. long and 5½ in. in height and breadth. The imperfect teeth were estimated to have been originally at least 10 in. long. The fragment was tentatively identified as a portion of a mandible of an ichthyosaurus. In 1923, the late Mr. Heber Longman, then director of the Queensland Museum, decided that it belonged to a new type of plesiosaur, and the animal was named *Kronosaurus queenslandicus*. In 1931, Mr. William Schevill, of the Museum of Comparative Zoology at Harvard College, U.S.A., while passing through Army Downs, North Queensland, noticed a number of fossil bones partly showing in the Lower Cretaceous rocks. Four and a half tons of rock was blasted out with dynamite and packed and despatched to the Museum at Harvard. After its arrival, Arnold Lewis, a Museum assistant, attempted to free the bones from the hard rock. About six months ago this work was successfully completed, and the skeleton was put together under the direction of the Museum director, Dr. Alfred S. Romer. The skeleton is 42 ft. in length. It has a triangular-shaped skull, 9 ft. long, with eighty spiked teeth each up to 8 in. in length. The characters of the teeth and mandible are identical with those of the mandible fragment recorded by Longman in 1923 (*Austral. Mus. Mag.*, 13, No. 2, June 15, 1959).

Syncarid Crustacea

Until recently only one syncarid was known from the Australian mainland (*Austral. Mus. Mag.*, 13, No. 2, June 15, 1959). This is *Koonunga*, which was described in 1907. Originally it had been found at Ringwood, now an outer suburb of Melbourne, and the stream in which it lived was long ago converted to a storm-water drain. In 1930 it was reported that *Koonunga* was extinct. During the past few years it has turned up in a variety of places, and is now known to occur sporadically across the southern part of Victoria. *Koonunga* is about one-third of an inch long, brownish in colour, and has a slender, almost cylindrical body. Its eyes are very small, and, unlike those of *Anaspides* and shrimps, are not stalked. It can swim actively, using its legs and abdominal appendages, but is more often found running rapidly over the bottom of pools and streams. This method of locomotion is so distinctive that *Koonunga* cannot be mistaken for any other aquatic animal. It relies on its agility and on its capacity for burrowing into mud to escape from enemies, for it is helpless against predatory aquatic insects.

Koonunga lives in small permanent or semi-permanent swamps and in pools in streams which flow vigorously only after heavy rains. Since many of these places are apt to become dry during the summer, and since the adults cannot withstand desiccation, it had been supposed that *Koonunga*, like so many other freshwater crustaceans, would lay drought-resistant eggs. It is now known, however, that the breeding season is during winter. The eggs, which are inserted singly or in small batches into decaying plants, develop over a period of about two months and hatch in the spring. It appeared that *Koonunga* could survive drought only by descending underground; they have been obtained from pits 2–3 ft. deep in the beds of dried-out streams. *Koonunga* can burrow swiftly into soft mud, but would not seem capable of forcing its way through heavy subsoil. The indications are that, in making its descent, it uses the burrows of freshwater crayfish. These crayfish are known to follow the water-table down to a depth of 6 ft. or more, and could thus provide a safe refuge for *Koonunga* during periods of drought. In some places *Koonunga* must remain underground continuously for six months or more. From this mode of life it would seem only a short step to a wholly subterranean existence, and work in Victoria over the past few years indicates the presence of a rich underground fauna of syncarids. Already, four new species have been found. They lack eyes, and have suffered a general reduction in pigmentation so that they have a translucent, white appearance. The largest species is nearly half an inch long, the smallest only one-sixth of an inch. Though these syncarids are typically subterranean in habit, they may, in special circumstances, live in surface water, and this is where they have been found. Pools are advantageous to syncarids in that few other aquatic animals live in them and there is little competition. The survival of *Anaspides* almost unchanged since Palæozoic times has been attributed to its living in a stable environment and to its freedom from predation. Conditions on the mainland are less stable. *Koonunga* and its allies would seem to owe their survival to their close association with the freshwater and land crayfishes.

The Liverpool Geological Society

The centenary of the Liverpool Geological Society will be celebrated during January 1–3 by a three-day meeting devoted to recent advances in geology. At this meeting, run jointly with the eighth Inter-University Geological Congress in the University of Liverpool, the following addresses will be delivered: Dr. W. S. Mackenzie, on "Experimental Petrology", Prof. S. I. Tomkeieff, on "The Progress of Geology in the U.S.S.R.", Dr. G. Voll, on "Petrofabrics and Small-scale Structures", Prof. C. F. Davidson, on

"Aspects of Radiogeology", Dr R W Girdler (in the absence of Dr R G Mason), on "Geophysical Researches on the Sea Floor", Dr J A Clegg, on "Palæomagnetism", Prof W C Krumbein, on "Numerical Data in Geology", Dr L M J U van Straaten, on "Deltaic Sedimentation", Dr R H Cummings, on "Micropalæontology", Dr J S Weiner (in the absence of Prof T S Westoll), on "Sequences in Hominoid Evolution" The address by Prof T S Westoll on "Vertebrate Palæontology", though not given at the meeting, will be published with the other addresses in January in the centenary issue of the *Liverpool and Manchester Geological Journal* Dr Clegg's and Dr Weiner's addresses will be published in abstract Details of the meeting can be obtained from R G C Bathurst, Department of Geology, University of Liverpool

The Night Sky in January

FULL moon occurs on Jan 13d 23h 51m U T and new moon on Jan 28d 06h 16m The following conjunctions with the Moon take place Jan 10d 09h, Aldebaran 0 7° S, Jan 25d 08h, Jupiter 5° S, Jan 25d 15h, Venus 4° S In addition to these conjunctions with the Moon, Venus is in conjunction with Antares on Jan 9d 04h, Venus being 7° N, Mercury with Saturn on Jan 11d 04h, Mercury being 1 8° S, Venus with Jupiter on Jan 21d 11h, Venus being 1 1° N, and Mars with Saturn on Jan 31d 11h, Mars being 1 2° S Mercury is too close to the Sun for observation Venus is a morning star, visible low in the south-east before sunrise It rises at 4h 40m and 5h 45m on January 1 and 31, respectively Its stellar magnitude is −3 6, its distance increases during the month from 98 to 116 million miles and the visible portion of the apparent disk increases from 0 714 to 0 809 Mars is badly placed for observation, rising about an hour before the Sun Jupiter is a morning star, rising at 6h 30m, 5h 50m and 5h 00m on January 1, 15 and 31, respectively It may be seen low in the south-east before sunrise, its stellar magnitude is −1 4 Saturn is too close to the Sun for observation Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich Jan 10d 17h 39 7m, 318 *B* Tau (*D*), Jan 11d 17h 41 9m, 130 Tau (*D*), Jan 12d 20h 12 7m, 26 Gem (*D*) *D* refers to disappearance The Quadrantid Meteors are active on January 3–4, with a predicted maximum at Jan 4d 05h The radiant is near R A 15h 28m, Dec +50°, and conditions are favourable for observation The Earth is at perihelion on January 4, its distance from the Sun being 91 4 million miles

University News

Birmingham

DR A P D THOMSON, senior lecturer in anatomy, has been appointed acting director of the Department of Anatomy as from January 1 The following appointments have been made Dr D S Urch, lecturer in chemistry, J C Maltbaek, lecturer in mechanical engineering, G C-Y Hu, lecturer in highway and traffic engineering, G H J Bennett, lecturer in industrial metallurgy Dr C G Wall, lecturer in chemical engineering, R H Jones, assistant lecturer in civil engineering, P J Waterton, staff Fellow in physics, Dr V Knapp, research Fellow in nuclear physics, Dr M Gage, research Fellow in geology, M H B Hayes, I C I Fellow in chemistry, Dr J P Simons, Fellow in chemistry, D W Thomas, National Coal Board research Fellow in physical chemistry

Glasgow

THE Minister for Science, the Right Hon the Viscount Hailsham, was elected Rector of the University on October 26

The new Engineering Building was inaugurated by the Right Hon the Viscount Montgomery of Alamein on November 4

The following have been appointed to lectureships R E Azuma and W R Hogg, experimental and theoretical physics, Helen S Dunsmore and G S Harris, chemistry, W Graham Jardine, geology, and J Leech, computing laboratory, and the following to research fellowships A Bhati, A C Day, W J McMaster and W Parker, chemistry, J D Roycroft, solid state physics, and Wm C Russell, virology (first Lock fellowship)

For the present session, 392 new students (302 men and 90 women) have been admitted to the Science Departments, compared with 372 in 1958 The total of matriculated students in the University as a whole now stands at 6,566, compared with 6,330

Southampton

THE following appointments have been announced Dr E M Wilson, senior lecturer and director of computation, Mr P C Parks, lecturer in aeronautical engineering, Mr G G Bloodworth, lecturer in electronics, Mr J F Barrett, De Havilland research Fellow in aeronautical engineering, Mr M T Thew, Vokes research Fellow in mechanical engineering

Announcements

THE fifth Levinstein Memorial Lecture of the Society of Chemical Industry will be delivered by Mr L H Williams on February 5 He will speak on "The Future of Chemicals from Petroleum" and the lecture, which is open to the public, will be given in the Large Chemistry Theatre, University of Manchester at 6 30 p m

THE British Welding Research Association and the Engineering Department, the University of Cambridge, are jointly organizing a symposium under the title of "Fatigue of Welded Structures" This is to be held in the Department of Engineering at the University of Cambridge during March 29–April 1 Further information can be obtained from the British Welding Research Association, Abington Hall, Abington, Cambs

A POSTGRADUATE course of nine lectures on "Newer Developments in the Chemistry of the Non-Metals" will be given at Kingston Technical College during January 27–March 23 The fee for the course is £1 2*s* 6*d* Further information can be obtained from the Principal, Kingston Technical College, Fassett Road, Kingston-upon-Thames

KODAK, LTD, are offering up to six annual scholarships to be known as "Kodak Scholarships in Colour Photography" Successful candidates will be given about three months specialized instruction in the laboratories and studios of the Eastman Co in Rochester, New York Approved expenses will be paid Further information can be obtained from the Secretary, Kodak, Ltd, Kingsway, London, W C 2

BRITISH AGRICULTURAL HISTORY SOCIETY

THE British Agricultural History Society held its annual winter conference, in co-operation with the Association of Agriculture, at the Institute of Education, University of London, on December 5, under the chairmanship of its newly elected president, Sir Keith Murray, who was welcomed with acclaim. Sir James Scott Watson retired this year after having been president of the Society since its inception in 1953.

Unfortunately, sudden illness prevented Mr. W. B. Mercer from attending to give his proposed lecture on the "Development of Agricultural Education and Advisory Services". This hiatus in the programme was ably filled by Mr. T. W. Fletcher, of the Department of Agricultural Economics, University of Manchester, with a paper on "Lancashire Livestock Farming in the Great Depression".

Mr. Fletcher, whose views on the farming history, especially of Lancashire, in the past three decades of the nineteenth century are somewhat revolutionary, showed that the livestock farmers of Lancashire did not, in fact, suffer in the depression. On the contrary, their standards of output, purchase of imported concentrates and other feeding stuffs, as well as their incomes, improved. The reasons for this were not far to seek. The local demand, both number of urban mouths and size of urban incomes, was growing. Consequently, the livestock farmers had a market, so to speak, on their doorstep for all the milk, butter, cheese, beef, mutton and pork that they could produce. On the east side of the county, too, there was a large demand from the West Riding industrial district. In such circumstances, it is not surprising to learn that rents were well paid and stable, and that relations between landowners and tenants were amicable.

The afternoon session was opened by Mr. O. R. McGregor, reader in social institutions, University of London, with a paper, "Free Trade in Land in the Victorian Period". Mr. McGregor argued, in a way that would certainly have pleased Maitland and Vinogradoff, that in any event for the nineteenth century the study of the social institutions surrounding farming was more important than the study of the development of technical changes. With wide reference to contemporary dialectic he emphasized the conflict between the rising class of urban industrialists and of the small number of great landowners (not more than about a thousand) who were striving by all means to retain their dominance of the political scene, and the prestige and patronage, for example, in Army and Church, that derived from it. He emphasized that the landowners, who used every possible device to prevent the break-up of estates—primogeniture, entail and settlements—regarded the land not so much as a rent- or food-producing commodity, but as a possession of social value. This outlook coloured their relation with their tenants, whom they wished to keep in mercy as tenants-at-will, and their attitude towards the increasingly wealthy and pugnacious middle classes who demanded 'free trade in land'. It was significant that so many members of the House of Commons before 1870 were landowners and land agents, not to speak of the House of Lords. This lecture certainly provided a new approach to the problems of farming history in the nineteenth century.

Finally, Miss Edith Whetham, Gilbey lecturer in the history and economics of agriculture, University of Cambridge, discussed "Cambridgeshire Tithe Maps, 1836–1890". She said that the county was backward in 1836 and that the tithe maps therefore gave a fine illustration of the change from open to enclosed fields in many parishes. She did not develop the subject at length, preferring to allow the documents exhibited, and the photostats passed around, to confirm it for her.

G. E. FUSSELL

NATIONAL RESEARCH COUNCIL OF CANADA

STRESS has been laid on a recent report on the support given to postgraduate research in the universities of Canada, for which some 34 million dollars have been provided by the National Research Council of Canada since 1917*. In the current year, 5.9 million dollars were provided for this purpose by way of 681 grants and 435 scholarships, fellowships and associateships, and expenditure is expected to reach 8.2 million dollars in 1959–60. The Council itself employs a scientific research staff of 613 (including 149 postdoctorate Fellows), 883 technicians and 887 general service and administrative staff. Much of the work of the Division of Applied Biology is in the applied field, and its statistical studies of short-term protein variability in cargoes of Northern wheat exported from Vancouver were expanded (in co-operation with the Grain Research Laboratory Board of Grain Commissioners) to permit accounting for this variability as the resultant of random differences between successive car loads from the same shipping point, of weekly variations in the geographical pattern of car-loads, and of mixing incidental to terminal limeing, handling and loading. A study of the effect of exposure on new-born caribou indicated that caribou calves are quite sensitive to cold and wind, to which they respond by a marked increase in metabolism. Investigations are also in progress on the fundamental properties of the hemicelluloses of common pulping woods, designed to assist pulp-makers in the production and use of semi-chemical pulp, but the report emphasizes that the biological sciences occupy an unfavourable position in the overall Canadian scientific effort.

At the Atlantic Regional Laboratory, Halifax, a chelating chemical as a dip before frying was found to prevent 'greying' in the production of partly precooked French fried potatoes, due to an abnormally high content of iron in the environment, while at the Prairie Regional Laboratory, Saskatoon, gas–liquid chromatography has been used for the quantitative determination of fatty acids in oils and fats, and a new type of foam breaker developed which operates on the principle of rapid acceleration of the foam through a nozzle, using only pressure from air charged into the fomenter The work of the Division of Applied Chemistry has gradually changed in recent years in an effort to obtain broader information in specific fields so that *ad hoc* problems have received less attention Much of its work is related to petroleum and corrosion chemistry In the Division of Pure Chemistry, which is organized in thirteen sections, outstanding achievements of the year were the determination of the total structure of aconitine, the establishment of characteristic zone patterns for each type of functional group, following the determination of the infra-red spectra of many steroids, and the development of the new technique, known as nuclear magnetic resonance, in which the nucleus within a molecule is used as a 'probe' to investigate details of molecular structure

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* Forty-Second Annual Report of the National Research Council of Canada, 1958–59, including the Annual Report of Canadian Patents and Development Limited. Pp. 26. (Ottawa: Queen's Printer, 1959.)

The Division of Applied Physics has produced a new kind of plotting instrument for making maps from air photographs, and the Division is also investigating the suitability of using for the measurement of time an invariable frequency of vibration emitted by some atom or molecule, and observations over six months have shown promising agreement of the cæsium 'clock' with the one at the National Physical Laboratory, Teddington Much cosmic-ray work was carried out for the International Geophysical Year by the Division of Pure Physics, and micro-wave technique was used to determine precisely the distances between the atoms in molecules of acetone, propiolic aldehyde, vinyl cyanide, nitric acid, methyldifluorsilane and formamide, while a detailed theory has been developed which appears to be in excellent agreement with experimental data on the multiple scattering of charged particles The thermoelectric powers of copper and silver, among others, at temperatures much below 1° absolute have been found to be extraordinarily high, higher by orders of magnitude than present-day theory predicted

In October 1958 the new Fire Research Building was officially opened as the final part of the Building Research Centre, and in its work of keeping the National Building Code of Canada up to date the Division of Building Research has undertaken studies of the actual loads on structures due to floor loadings, wind and snow In the Division of Mechanical Engineering, emphasis on projects relating to improvements in transport in Canada continued, including harbour improvements, winter navigation by water, rail transport and various aspects of the evolution of new aircraft capable of vertical take-off and landing

About half the programme of the Radio and Electrical Engineering Division was concerned with defence Techniques were developed for producing and measuring extremely low pressures in gases, and the Division co-operated with the National Aeronautical Establishment in developing a small radio transmitting beacon which is flung clear from the tail of the aircraft in the event of disaster In co-operation with the Marine Services Branch of the Department of Transport, electric circuits are being applied to marine navigational devices, often for isolated locations

DYNAMIC AND STATIC DEFORMATION OF ARMCO IRON

By H. P. TARDIF and P. CHOLLET

Canadian Armament Research and Development Establishment, Quebec

A RECENT article on the above subject[1] showed that the mechanical properties of Armco iron were slightly lower after a previous amount of dynamic prestrain than after the same amount of static deformation This finding confirmed the results of Campbell and Duby[2] but was contrary to those of Harris and White[3] The object of the present article is to give further results concerning the effects of variables such as amount of prestrain and temperature of deformation

The same method of dropping a weight on a specimen 0 75 in diameter and 1 5 in long placed on a large solid anvil was used By varying the height of drop, the velocity of impact and thus the amount of deformation were changed Other specimens were then deformed statically by the same amounts obtained during dynamic impact After deformation, the specimens were cut in two longitudinally, with one half hardness tested before ageing and the other after ageing The results are shown in Fig 1 The hardness was found to increase with amount of deformation for both static and dynamic deformation and the rate of increase in hardness was about the same for the two methods of prestraining The increase in hardness, however, is less for the dynamically than for the statically deformed specimens, for the whole range of deformation used, and this difference is approximately constant for that range of deformations

After ageing the difference in hardness is again approximately constant for both statically and dynamically deformed specimens If, on the other hand, one considers the difference in hardness between the aged and unaged condition for both static and dynamic prestrain, it will be seen that this difference increases with higher amounts of deformation This observation confirms established beliefs that the tensile strength of iron after strain-ageing increases with the amount of static prestrain It is seen here that the same phenomenon is observed with dynamic prestrain if we assume that tensile strength is proportional to hardness Hundy[4] has suggested that this effect could be ascribed to the formation of discrete submicroscopic carbide or nitride precipitates at dislocation junctures

The fact that hardness and other mechanical properties are lower after dynamic than after static prestrain was corroborated by compression and

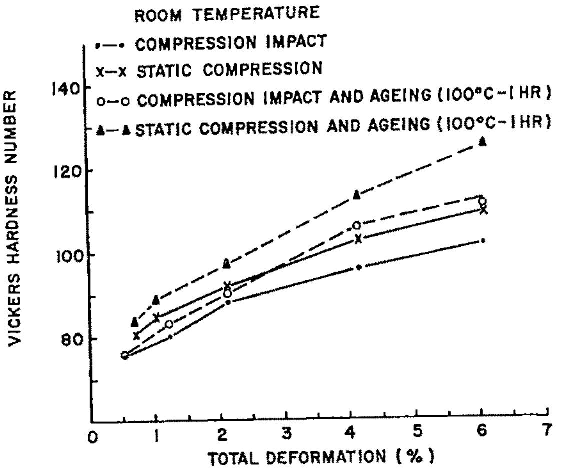

Fig. 1. Effect of total static or dynamic deformation on hardness before and after ageing

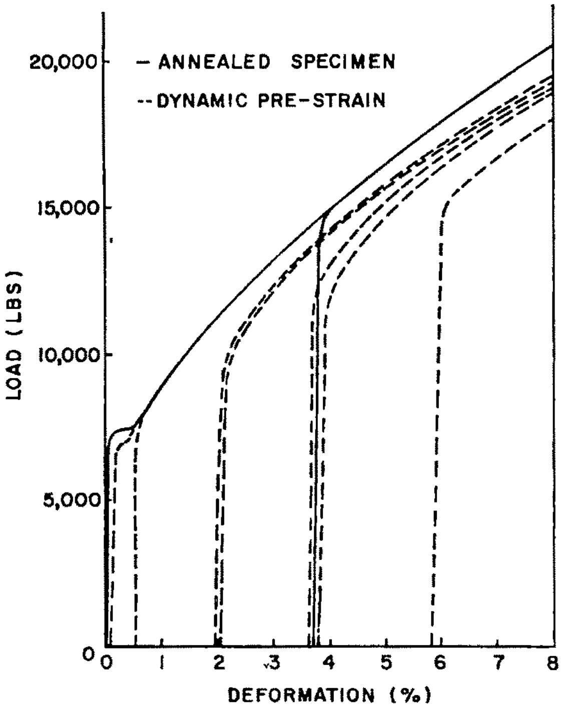

Fig. 2. Static load-deformation curves in compression showing softening of previously impacted specimens

tensile test results as shown in Figs. 2 and 3. The compression curves for specimens in the unaged condition all lie below the compression curves obtained for specimens deformed after comparable amounts of static prestrain. The same result was observed for statically and dynamically deformed specimens in the aged condition.

When the temperature is varied for a given height of drop, the same trends are observed, as seen in Fig. 4, except for the lowest temperature of testing (– 196° C.) where the results are about the same as those for the temperature of (– 75° C.). But again the hardness obtained after dynamic deformation is lower than that after static deformation, at all temperatures tested, both in the unaged and aged condition.

It can be assumed, as has been proposed by Campbell and Duby[2], that dynamic impact will activate a larger number of dislocations than static deformation because of the much higher stresses applied during the short-time dynamic loading. The larger number and more uniform distribution of free dislocations when compared with the same amount of static prestrain will permit the metal to deform more easily upon subsequent reloading. Consequently, the static mechanical properties of a dynamically prestrained specimen should be lower than that of a statically prestrained specimen as is seen to be the case from hardness, compression and tensile tests.

In two other series of tests, the deformation was restrained to a constant value while the temperature and the height of drop were varied. This restriction of the amount of deformation was accomplished by inserting an impactor arrester around the specimen, so that the impactor would be stopped at a given height and deform specimens by constant amounts independently of height of drop and temperature. The results seen in Fig. 5 show that the hardness of the dynamically deformed specimens, especially for the unaged condition, does not vary appreciably with height of drop, that is, velocity of impact, or with temperature for a constant deformation. This would thus imply that in the case of dynamic deformation the work-hardening is independent of velocity and temperature of deformation in the ranges used and that the hardness is a function mainly of the amount of deformation.

A similar conclusion had been reached previously by Campbell and Maiden[6], who prestrained two specimens by the same total amount of deformation, one by impacting twice at – 84° C. at 503 in./sec., the other by impacting once at room temperature at 460 in./sec. No significant difference was observed in the stress-strain curve, indicating that the shape

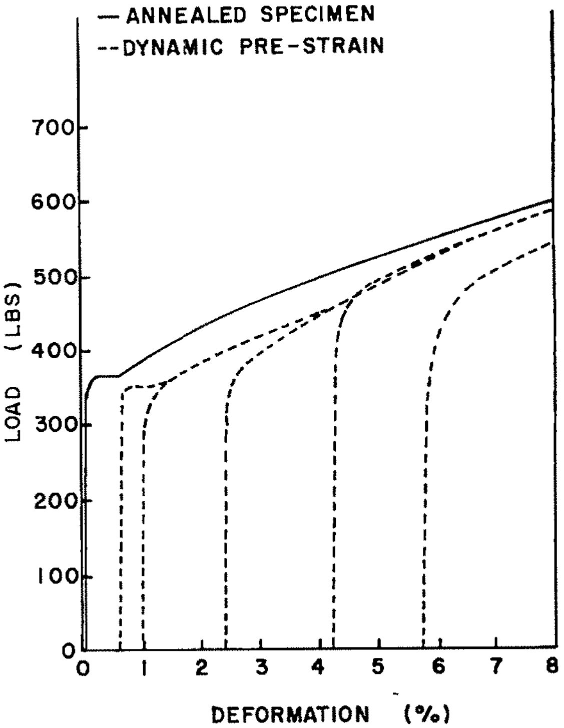

Fig. 3. Static tensile test results on annealed and dynamically prestrained specimens

of the curve was dependent mainly on the amount of deformation and not on the temperature, velocity or even number of impacts during deformation.

On a dislocation basis, it would also appear that the number of dislocations produced is independent of velocity of deformation and of temperature of tests but would depend mainly on the amount of deformation during the impact as was discussed previously[5]. The increase in hardness after ageing these specimens was also independent of height of drop and temperature.

It was thought of interest to determine the effect of temperature of static prestraining on the mechanical properties during subsequent static deformation at room temperature. Fig. 6 shows that low-temperature static prestraining has an effect similar to that of a dynamic prestrain in lowering the stress-strain curve below that obtained after static prestrain at room temperature.

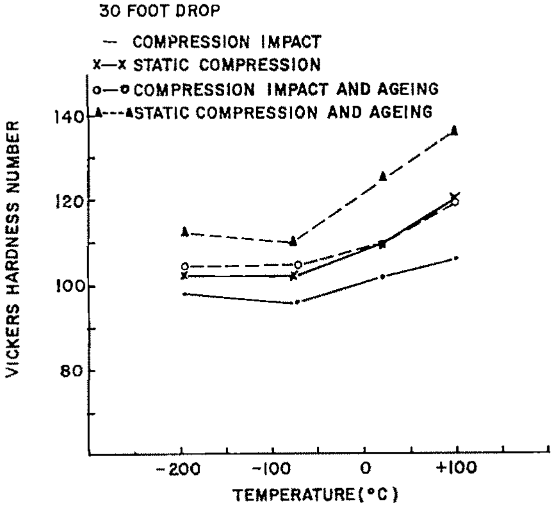

Fig. 4. Effect of temperature of deformation on hardness of statically and dynamically deformed specimens

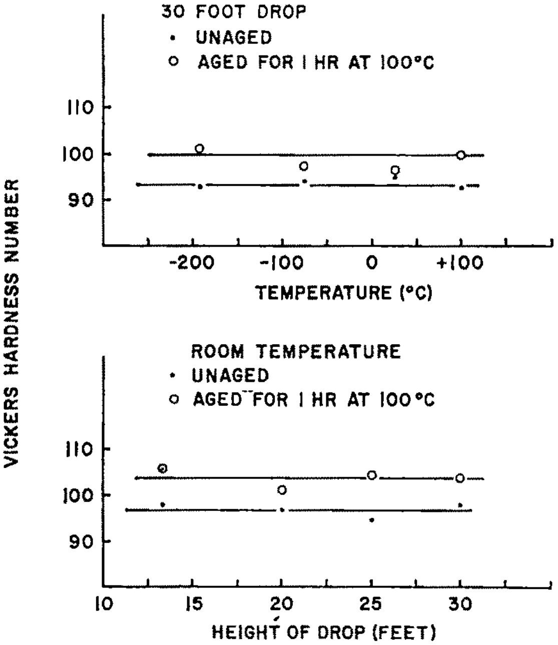

Fig. 5. Effect of temperature and velocity of deformation in 'restrained deformation' tests on resultant hardness

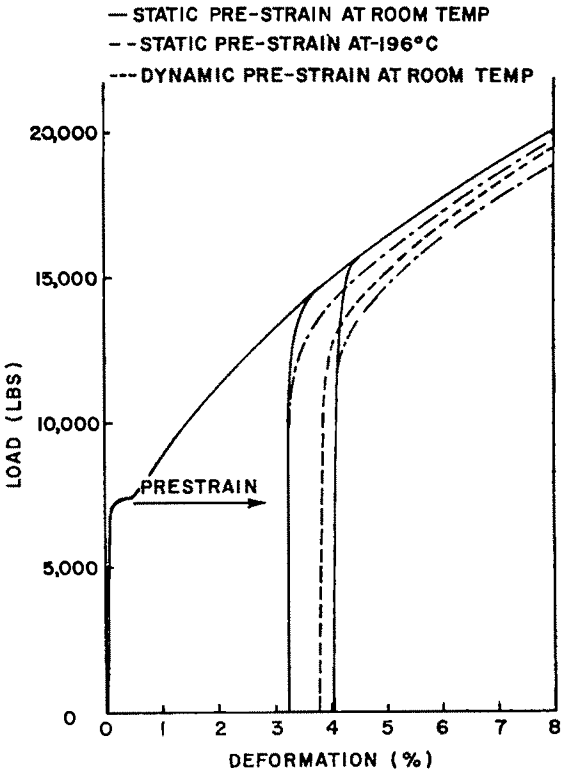

Fig. 6. Static load-deformation curves in compression for unaged, statically and dynamically prestrained specimens, illustrating the equivalence of strain-rate and temperature

This would mean that Campbell and Maiden's observation[5] that there was little difference in the stress-strain curves for the two specimens impacted at different temperatures and our observation of Fig. 5 where hardness is independent of temperature of deformation would only apply for dynamic prestrain. In the case of static prestrain, prestraining at low temperature will have an effect on the subsequent static curve, equivalent to that of a dynamic pre-deformation. By extending Campbell and Duby's theory one could say that the activation of a larger number of dislocation sources taking place under impact also takes place during low-temperature static deformation. At low temperature, the stress that must be applied to produce deformation is much higher than at room temperature (the 0·2 per cent proof stress being 3½ times higher than at room temperature for the Armco iron tested), permitting a larger number of dislocation sources to be released if we assume that dislocation sources can be released over a range of activation energies. On this basis, one would expect diffuse slip during static deformation at low temperature, and this was observed to be so in the course of metallographic examination of specimens. In a very recent paper Maiden and Campbell[6] have in fact observed the presence of diffuse slip during static deformation at low temperatures, and the equivalence of high strain-rates and low temperatures on mechanical properties of low carbon steels.

This article corroborates the foregoing observations on iron and extend them to the case of prestraining under these conditions.

It thus seems that the equivalence of effects of high strain-rates and low temperatures does not apply only during deformation as is already known, but also that their effects during prestraining will influence the behaviour of iron in the same direction during subsequent straining

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[2] Campbell, J D, and Duby, J, *Proc Roy Soc*, A, **236**, 24 (1956)

[3] Harris, D B, and White, M P, *J App Mech*, **21**, 194 (1954)

[4] Hundy, B B, *Metallurgia*, **53**, 203 (1956)

[5] Campbell, J D, and Maiden, C J, *J Mech Phys Solids*, **6**, 53 (1957)

[6] Maiden, C J, and Campbell, J D, *Phil Mag*, **3** (32), 872 (1958)

AGGREGATION OF AN ACRIDINE DYE ON NATIVE AND DENATURED DEOXYRIBONUCLEATES

By Dr D. F. BRADLEY

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AND

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ACRIDINE orange has been shown[1] to form aggregates or 'stacks' when bound to polyanions The strength of the dye–dye interaction depends upon the polyion used, and is, in general, greater with flexible than with rigid polymers Since deoxyribonucleic acid undergoes a transition from a rigid, two-stranded helix to a flexible, random coil upon heating[2], it might be expected that an increase in dye–dye interaction would accompany this transition We wish to report the observation of such an increase in dye-stacking tendency accompanying the heat denaturation of deoxyribonucleic acid

Calf thymus deoxyribonucleic acid ('Sigma') was denatured by slowly heating a solution (2 mgm /ml, $M/1{,}000$ cacodylate buffer $pH = 6\ 7$) and removing aliquots after 10 min at specified temperatures The helix → coil transition was followed by the drop in viscosity and the increase in ultra-violet absorption at 260 mμ (Table 1 and Fig 1), and because of the low ionic strength used, occurred at relatively low temperatures ($T_m = 62°$)

Spectrophotometric titrations of acridine orange with native and denatured deoxyribonucleic acids were carried out as previously described[1] Sharp end-points were obtained at 1 deoxyribonucleic acid phosphate per acridine orange ion (Fig 2) The volume of deoxyribonucleic acid required to titrate a given amount of dye did not change with denaturation (Table 1), showing that no additional binding sites were produced by heating The end-point of the titration therefore provides a method for determining the concentration of deoxyribonucleic acid which is convenient, independent of the extent of denaturation, and which requires only a small amount of deoxyribonucleic acid (about 2–20γ)

Sedimentation studies showed essentially complete binding of the dye at the 1 1 point under the conditions used ($1\ 6 \times 10^{-5}$ M acridine orange, 1×10^{-3} M cacodylate buffer, $pH = 6\ 7$) At the 1 : 1 point, therefore, each deoxyribonucleic acid binding site is occupied, and every dye molecule has a dye molecule on each adjacent site with which to interact The spectrum of the dye in this 1 1 complex shows two bands, an α band or shoulder at 492 mμ which predominates in the free-acridine orange monomer spectrum and a β band at 464 mμ which predominates in the free acridine orange dimer spectrum[1,3] The relative heights of these two bands (β/α ratio) may therefore be considered to be a measure of the dimeric character of a dye molecule which is involved in the maximum number of dye–dye interactions possible on the particular polyanion As can be seen in Table 1 and Fig 1, this measure (β/α ratio) of dimeric character, or of stacking tendency, increases with denaturation, and further, the fractional increase in β/α follows closely the fractional changes in both viscosity and ultra-violet absorption

When measured under the above conditions, the β/α ratios of 1 1 complexes of acridine orange with a number of different native deoxyribonucleic acid samples are all about 1 28 (Stone, A L, and Bradley, D. F, unpublished results), so that a low β/α ratio of this magnitude may be used as one criterion for the 'nativeness' of deoxyribonucleic acid However,

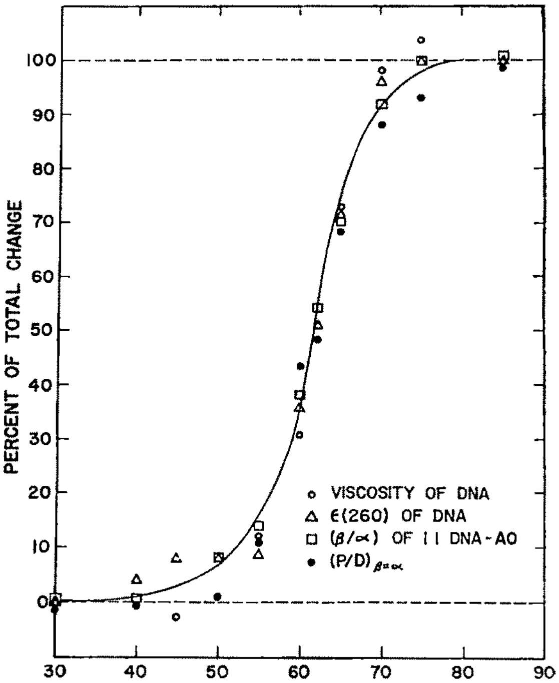

Fig 1 Thermal denaturation of deoxyribonucleic acid as measured by changes in properties of deoxyribonucleic acid and deoxyribonucleic acid-bound acridine orange Abscissa temperatures to which deoxyribonucleic acid solutions were heated Ordinate fractional changes in viscosity and ultra-violet absorption of deoxyribonucleic acid, and of visible absorption of acridine orange bound to the heated deoxyribonucleic acid For precise definition of quantities see legend to Table 1

Table 1 SUMMARY OF DATA ON THE HEAT DENATURATION OF DEOXYRIBONUCLEIC ACID

Sample	DNA viscosity $[\eta]$	%	Ultra-violet absorption E_{260}	%	ml DNA/ mole AO ($\times 10^{-8}$)	Dimeric character $(\beta/\alpha)_{1\ 1}$	%	Unstacking rate $dE/d(P/D)$	%	Equal α and β bands $(P/D)_{\beta=\alpha}$	%	Stacking coefficient K
Native CT-DNA			6,000		1 02	1 31		9,200		1 91		1 16 ± 0 14
CT, 30°	3,100	0	5,800	0	1 03	1 28	0	8,600	0	1 93	0	
CT, 40°			5,900	4	1 04	1 28	0	8,300	12	1 93	0	
CT, 45°	3,200	−3	6,000	8	1 04			8,300	12			
CT, 50°			6,000	8	1 05	1 31	8	8,700	−4	1 94	1	
CT, 55°	2,800	12	6,000	8	1 01	1 33	14	7,500	44	2 09	11	
CT, 60°	2,200	31	6,700	36	1 03	1 42	38	5,200	96	2 54	43	
CT, 62°			7,070	51		1 48	54	5,540	82	2 61	48	2 15 ± 0 07
CT, 65°	1,000	73	7,600	72	1 07	1 54	70	5,200	96	2 92	69	
CT, 70°	310	98	8,200	96	1 08	1 62	92	5,100	100	3 19	88	
CT, 75°	130	104	8,300	100	1 01	1 65	100	5,200	96	3 26	93	
CT, 85°	240	100	8,300	100	0 91	1 65	100	5,100	100	3 36	100	
Boiled CT-DNA			8,800		1 15	1 64		6,400		3 17		5 36 ± 2 44
SS-DNA	90		7,500			1 54		4,450		3 68		3 49 ± 0 48
S-RNA			7,750			1 57		3,260		4 82		3 27 ± 0 13
AT-RNA			7,890			1 72		4,960		4 90		3 22 ± 0 32

CT, calf thymus deoxyribonucleic acid (Sigma Chemical Co), SS-DNA, salmon sperm deoxyribonucleic acid (California Foundation), S-RNA, soluble rat liver ribonucleic acid (S Luborsky), AT-RNA, ascites tumour ribonucleic acid (J Colter) $[\eta]$ is ηsp /c in cm ^{3}gm $^{-1}$ of 0 004 per cent deoxyribonucleic acid solutions in 0 25 M sodium chloride measured at an average shear $(\overline{\beta})$ of 209 sec $^{-1}$ E_{260} is the molar extinction of deoxyribonucleic acid at 260 mμ calculated using the deoxyribonucleic acid phosphate molarity obtained from the spectrophotometric titration with acridine orange ml DNA/mole AO is the volume of deoxyribonucleic acid required per mole acridine orange to reach the 1 1 point in the spectrophotometric titration with acridine orange (about 4 6 × 10^{-8} mole) $(\beta/\alpha)_{1\ 1}$ is the ratio of extinction at 464 mμ to 492 mμ of the dye in the 1 1 complex $dE/d(P/D)$ is the initial rate of change in E_{504} mμ with phosphate/dye ratio for $P/D > 1$ $(P/D)_{\beta=\alpha}$ is the ratio of deoxyribonucleic acid phosphates to acridine orange ions at which the extinctions at 464 and 492 are equal K's are the stacking coefficients (see text) with their mean deviations %'s are percentage changes in properties between 30 and 85°

since the 1 1 complex is quite easily dissociated into free acridine orange and deoxyribonucleic acid by dilution or by added salts, resulting in an increased α (monomer) band and spuriously low β/α ratio, the conditions under which β/α is determined must be carefully controlled For example, the complex may be 50 per cent dissociated (β/α = 1 0) either by lowering the acridine orange concentration to 0 8 × 10^{-5} M or by raising the buffer concentration to 4 × 10^{-3} M This extreme sensitivity to salt concentration accounts for the failure of Steiner and Beers[4] to observe a 1 1 complex with native deoxyribonucleic acid in 0 06 M salt and 0 7 × 10^{-6} M acridine orange However, these authors do observe a 1 1 complex with boiled deoxyribonucleic acid under these same conditions, indicating that the dye–polymer interaction is increased by disruption of the ordered deoxyribonucleic acid structure Kurnick[5] and Lawley[6] have also noted that heat denaturation and depolymerization affect the affinity of deoxyribonucleic acid for methyl green, rosaniline, and 5-aminoacridine

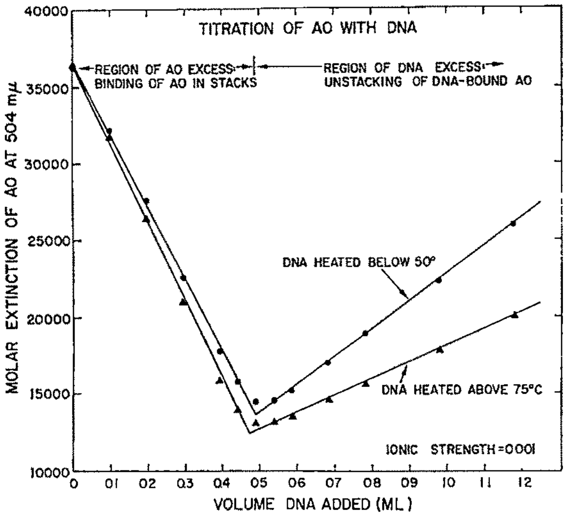

Fig 2 Spectrophotometric titration of acridine orange with deoxyribonucleic acid Molar extinctions of dye at 504 mμ calculated from volume-corrected optical densities M/1,000 cacodylate buffer, pH 6 7 Deoxyribonucleic acid solutions about 0 04 mgm / ml Upper curve, deoxyribonucleic acid solution (2 mgm /ml) slowly heated to 50° C , aliquot removed after 10 min , cooled and diluted , moles acridine orange = 4 65 × 10^{-8}, molarity acridine orange at end-point = 1 61 × 10^{-5} , lower curve, same as above but heated to 75° C , moles acridine orange = 4 60 × 10^{-8}, molarity acridine orange at end-point = 1 60 × 10^{-5} Titrations carried out at 27–28° C

$T2$ phage deoxyribonucleic acid prepared by the phenol extraction method is unique in showing β/α = 1 0 under all conditions, suggesting that either this deoxyribonucleic acid is more native than the others, or that stacking and/or binding is interfered with by the glucose groups or by residual bound spermine, etc Despite such variations in its absolute numerical value, the fractional increase in β/α with denaturation follows closely the viscosity and ultra-violet absorption curves under a variety of experimental conditions

On the deoxyribonucleic acid-excess side of the 1 1 point the bound acridine orange molecules begin to unstack as they distribute among the total available binding sites The extinction at the wave-length maximum (504 mμ) of bound, unstacked acridine orange therefore rises[1] As can be seen in Fig 2, the rate of unstacking is faster in deoxyribonucleic acids which have not been heated above the transition temperature The fractional decrease in unstacking rate (expressed as $dE/d(P/D)$, where P/D is the number of deoxyribonucleic acid phosphates per acridine orange ion) accompanying denaturation appears to lead the changes in other properties by about 5° C (Table 1), suggesting that deoxyribonucleic acid may undergo another structural transition which precedes that measured by viscosity, ultra-violet absorption, and β/α ratio changes

As unstacking proceeds with increasing P/D ratio the α (monomer) band increases and β (dimer) band falls The P/D at which the β/α ratio has fallen to unity may be used as a third measure of stacking tendency, and as shown (Table 1, Fig 1) this measure also follows quantitatively the viscosity–ultra-violet absorption transition

When the titration is carried to sufficiently high P/D (about 100 for deoxyribonucleates) the extinction at 504 mμ reaches a plateau corresponding to complete unstacking It has been shown[1] that the fraction of unstacked acridine orange, F, is related to P/D by a single-parameter equation

$$P/D = (1 - F^{1/2})^{-1} + (K - 1)(1 - F^{1/2})^{-1}(1 + F - F^{1/2})F^{1/2}$$

in which *K*, the stacking coefficient, is an absolute measure of stacking tendency defined in terms of a mathematical model of the stacking process. The value of *K* calculated from the plot of E_{504} vs P/D turns out to be 1·16 ± 0·14 for calf thymus deoxyribonucleic acid and very close to this value for a number of other preparations (Stone, A. L., and Bradley, D. F., unpublished results). A value of $K = 1$ corresponds to no stacking tendency, that is, to a completely random distribution of dyes among sites, and therefore native deoxyribonucleic acid, with a *K* value close to unity, nearly corresponds to this situation. This finding is in agreement with Lawley's[7] conclusion that rosaniline dimerizes on native deoxyribonucleic acid in "tolerable agreement" with a random distribution model.

It has been reported[1] that deoxyribonucleic acid and ribonucleic acid have similar stacking coefficients (with $K = 2·9$ and 3·3 respectively). It is apparent from the present findings that this conclusion was based upon experiments with partially denatured salmon sperm deoxyribonucleic acid (Table 1). Indeed, a comparison of the various measures of stacking suggests that unheated ribonucleic acid is more like denatured deoxyribonucleic acid than native deoxyribonucleic acid in those structural features responsible for dye stacking, for example, in having regions of both coiled and helix structure[8].

The data for the unstacking of boiled deoxyribonucleic acid, however, do not show good fit to the stacking equation ($K = 5·36 \pm 2·44$). A normal stacking curve (*K* about 3) is followed up to approximately 40 per cent unstacking. Beyond this, unstacking proceeds at a much slower rate, which is linear in log P/D, resulting in a higher average stacking coefficient than ribonucleic acid. This apparent increase in stacking tendency or flexibility at $P/D > 4$ may possibly be related to changes in the net charge on the deoxyribonucleic acid as the fraction of sites occupied by the acridine orange cations decreases, or to the presence in the boiled sample of a mixture of deoxyribonucleates with different binding affinities and stacking tendencies.

These results show that the tendency of acridine orange to aggregate is quite low when bound to native deoxyribonucleic acid, but that it increases markedly as the deoxyribonucleic acid is denatured. Several quantitative measures of stacking tendency have been described which may be used to estimate the extent of denaturation in partially denatured deoxyribonucleates. These findings provide additional evidence that the stacking tendencies of polyanions are intimately related to their structure in a qualitatively predictable manner. Furthermore, they may provide an important clue to understanding the complex colour patterns observed when acridine orange is used to stain tissues and, in particular, the general shift to dimeric character (enhancement of red phosphorescence) when living, stained cells are destroyed[3].

We wish to express our appreciation to Dr. A. L. Stone for helpful discussions, to Mrs. J. Johnson and Mrs. S. Huang for technical assistance, to Dr. S. Luborsky for a sample of soluble ribonucleic acid, and to Dr. J. S. Colter for a sample of mouse ascites tumour ribonucleic acid. One of us (G. F.) has been supported in part by a grant (*C*-3883) from the National Cancer Institute, U.S. Public Health Service.

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EFFECT OF CHLORPROMAZINE UPON ISOLATED *d*-AMINO-ACID OXIDASE SYSTEMS

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YAGI, Nagatsu and Ozawa[1] reported recently that chlorpromazine (N-[3′-dimethylaminopropyl]-3-chlorophenothiazine) is an inhibitor of *d*-amino-acid oxidase. They stated that substantial inhibition was achieved with 2×10^{-5} *M* chlorpromazine in a system consisting of a hog kidney *d*-amino-acid oxidase preparation, $1·6 \times 10^{-7}$ *M* flavin adenine dinucleotide, and $6·25 \times 10^{-2}$ *M* *d*-alanine, buffered at *p*H 8·3 with pyrophosphate (no temperature was given, nor the gas phase indicated). They also noted that marked inhibition was observed with the same concentration of chlorpromazine in the oxygen uptake of a freshly excised dog diencephalon homogenate, in which the endogenous respiration was inhibited by potassium cyanide; this phenomenon was attributed to the inhibition by chlorpromazine of *d*-amino-acid oxidase in the tissue, and it was suggested that there might be some relationship between the inhibition of flavin enzymes by chlorpromazine and the pharmacodynamic properties of the tranquillizing agent. In connexion with a study of the effect of gradual changes in the molecular constitution of synthetic entities upon isolated enzyme systems known to be associated with brain metabolism, we became interested in pursuing this work further.

Procedure 1. The work was carried out on a *GME*-Lardy *WB*-3 type Warburg instrument, using 15-ml. flasks. We have chosen Worthington's hog kidney *d*-amino-acid oxidase preparation and Calbiochem's flavin adenine dinucleotide (assay, 91 per cent, California Corporation for Biochemical Research, Los Angeles, California) for our initial experiments; 1×10^{-1} *M* *dl*-alanine was adopted as substrate after a study of the enzyme activity under varying enzyme and substrate concentrations (Worthington's *d*-amino-acid oxidase preparation is prepared by extracting the conventionally prepared hog kidney acetone powder with distilled water for 1 hr in the cold, centrifuging the mixture, and lyophilizing the extract immediately Worthington Biochemical Corporation, Freehold, New Jersey) The buffers used were 0 05 *M* KH_2PO_4–NaOH (*p*H 6 88), 0 025 *M* $Na_4P_2O_7$–HCl (*p*H 7 93), and 0 02 *M* $Na_4P_2O_7$–HCl (*p*H 8 27) The gas phase was air, and the temperature was 37° C The reaction volume totalled 3 2 ml, with 0 12 ml 20 per cent potassium hydroxide in the centre well (2 cm × 2 cm Whatman No 1 filter paper), and 0 4 ml substrate solution in the side-arm, all other reaction components were contained in the main compartment The inhibitors were introduced in 0 05 ml of aqueous solution, appropriately concentrated to yield the desired dilution of the compounds in the final reaction mixture Equilibration was initiated at − 45 min, with readings every 5 min beginning at − 25 min Dumping was effected at 0 min, with the side-arm being washed twice with the reaction mixture Each manometer was read at 10-min intervals during the reaction period of 0 to + 60 min The *p*H of the contents of the flasks was checked at the end of the experiment Each set of conditions was run (at least) in triplicate

Procedure 2 Some of the experiments required a change in the original arrangement (procedure 1) of the reaction components and the following modification was introduced the enzyme and inhibitor solutions (combined volume 0 65 ml) were placed in the side-arm, and the main compartment contained the coenzyme and substrate in the buffer balance (combined volume 2 43 ml) Otherwise the same procedure was followed

We expressed the rate as

$$V = \left[\frac{(\mu\text{l oxygen at 40 min}) - (\mu\text{l oxygen at 10 min})}{30}\right] \times 60$$

where *V* signifies µl oxygen/hr absorbed within the reaction interval of + 10 to + 40 min, during which the rate was always linear

Procedure 3 In experiments where the reaction was not preceded by an incubation period, the reactants were situated in accordance with the original arrangement (procedure 1), however, dumping was effected just prior to their exposure to the water-bath In this instance, the rate (*V*) was calculated from the reaction interval of + 30 to + 50 min, during which the rate was always linear

The percentage of inhibition (*I*) and potentiation (*P*) were calculated as follows

$$I = \left(\frac{V_c - V_i}{V_c}\right) \times 100 \qquad P = \left(\frac{V_p - V_c}{V_c}\right) \times 100$$

where V_c represents the control rate, V_i the inhibited rate, and V_p the potentiated rate

The chlorpromazine hydrochloride used in our experiments was furnished by Dr Paul Mattis of the Smith, Kline and French Laboratories in Philadelphia, Pa, the reserpine phosphate by Dr Albert J Plummer, of Ciba Pharmaceuticals in Summit, N J, *Ro*-1-9569/7 by Dr W E Scott, of Hoffmann-LaRoche, Inc, in Nutley, N J, and the *d*-lysergic acid diethylamide by Mr John M Cole, of Sandoz Pharmaceuticals in Hanover, N J

The enzyme systems used in the experiments were characterized kinetically (procedure 1) A linear reciprocal Lineweaver–Burk plot[2] of the enzyme activity, buffered with phosphate at *p*H 6 88, at varying enzyme and substrate concentrations, was graphically evaluated as suggested by Dixon[3] and Reiner[4], the Briggs–Haldane constants[4a,5] (0 059, 0 044, 0 041 and 0 051) did not vary significantly with enzyme concentration and were well within the range of variability for independent determinations in the systems investigated (Reiner, J M, personal communication, 1959) In pyrophosphate-buffered systems (*p*H 8 27), however, the enzyme activity did not yield a linear reciprocal plot, further discussion of this point is reserved for a future occasion

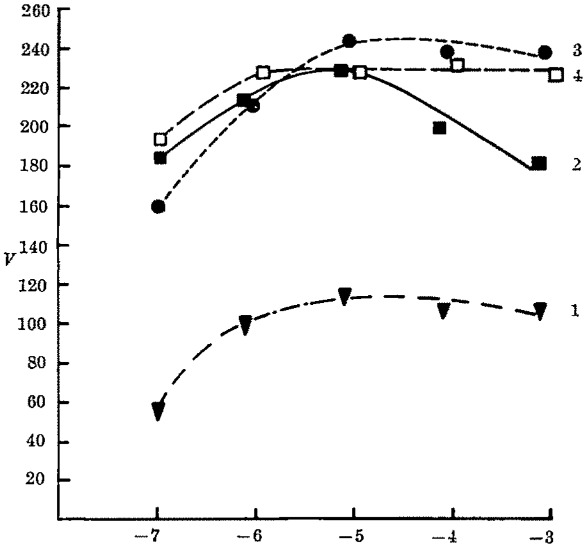

Fig 1 Comparative enzyme activity in phosphate- and pyrophosphate-buffered systems (in curves 1, 2 and 3, coenzyme incubated with enzyme according to procedure 1, in curve 4, coenzyme incubated with substrate according to procedure 2) Common 1 × 10^{-1} *M* *dl*-alanine, base level flavin adenine dinucleotide (estimated at 1 × 10^{-7} *M*/1 × *d*-amino-acid oxidase) Curve 1, 1 × *d*-amino-acid oxidase plus 7 83 × 10^{-7} to 7 83 × 10^{-4} *M* flavin adenine dinucleotide, 0 05 *M* phosphate, *p*H 6 88 Curve 2, 1 × *d*-amino-acid oxidase plus 6 73 × 10^{-7} to 6 73 × 10^{-4} *M* flavin adenine dinucleotide, 0 02 *M* pyrophosphate, *p*H 8 27 Curve 3, 2 33 × *d*-amino-acid oxidase plus 9 19 × 10^{-7} to 9 19 × 10^{-4} *M* flavin adenine dinucleotide, 0 05 *M* phosphate, *p*H 6 88 Curve 4, 1 × *d*-amino-acid oxidase plus 1 05 × 10^{-6} to 1 05 × 10^{-3} *M* flavin adenine dinucleotide, 0 02 *M* pyrophosphate, *p*H 8 27

Another kinetic study revealed additional differences between enzyme activities in phosphate (*p*H 6 88) and pyrophosphate (*p*H 8 27) buffered systems (Fig 1) Curves 1, 2 and 3 are results obtained with procedure 1 in which the enzyme and the coenzyme were pre-incubated in the same compartment Curves 1 and 2 represent the activity of a given quantity of *d*-amino-acid oxidase and tenth-molar *dl*-alanine within a range of concentrations of flavin adenine dinucleotide, in phosphate- and pyrophosphate-buffered systems Curve 3 represents the corresponding activity of 2 33 times the amount of *d*-amino-acid oxidase used in the first two series of experiments, which raised the oxygen uptake in the phosphate buffer to approximately the same level as that of the original enzyme concentration in the pyrophosphate buffer While the oxygen uptake differed quantitatively in the two phosphate-buffered experiments (Fig 1, curves 1 and 3), corresponding to the enzyme concentration, the curves of the flavin adenine dinucleotide catalysis retained the same form In the pyrophosphate-buffered experiment, however, the graph of the activity took on a considerably different pattern (Fig 1, curve 2)

Table 1 EFFECT OF PRE-INCUBATION UPON THE ACTIVITY OF THE HOG KIDNEY *d*-AMINO-ACID OXIDASE PREPARATION

(1 × *d*-amino-acid-oxidase with base-level flavin adenine dinucleotide (estimated, 1 × 10^{-7} *M*) and 1 × 10^{-1} *M* *dl*-alanine)

Buffer (*M*) and *p*H	Pre-incubation period at 37° C prior to reaction (min)	
	45	0
Pyrophosphate (0 025) 8 04	$V = 183$	$V = 180$
Phosphate (0 05) 6 84	$V = 76$	$V = 78$

When the coenzyme and the enzyme were pre-incubated in separate compartments (procedure 2), the pyrophosphate-buffered run yielded curve 4 of Fig 1 , the phosphate-buffered runs carried out under these conditions did not differ significantly from those represented by curves 1 and 3

Since Burton has found[6] that some *d*-amino-acid oxidase preparations are subject to thermal inactivation at 37 5° C in pyrophosphate-buffered (*p*H 8 27) systems, we have compared the activity of our enzyme systems in simultaneous runs with (procedure 1) and without (procedure 3) a 45 min pre-incubation period , the results are summarized in Table 1 While our enzyme systems were not affected by pre-incubation at 37° C , one should bear in mind that Burton apparently dealt with a purer and more sensitive sheep kidney preparation

We observed a 40 per cent inhibition with 1 × 10^{-3} *M* chlorpromazine in phosphate buffer (*p*H 6 88, procedure 1), but were unable to effect appreciable chlorpromazine inhibition in pyrophosphate buffers (*p*H 7 93 and 8 27) under similar conditions The inhibition in phosphate-buffered systems was substantially influenced by the flavin adenine dinucleotide concentration of the reaction mixture and by the exposure of the enzyme to the inhibitor during pre-incubation Our findings are summarized in Table 2

The effect of chlorpromazine upon phosphate-buffered systems with increasing flavin adenine dinucleotide concentrations is illustrated in Fig 2 (curve 2) The phenomenon of chlorpromazine potentiation at high concentrations of flavin adenine dinucleotide seems to be correlated with some inhibition by flavin adenine dinucleotide itself at such coenzyme-levels (Fig 2, curve 1), which tendency becomes even more conspicuous in curve 2 of Fig 1 This prompts the suggestion that complex formation between chlorpromazine and flavin adenine dinucleotide may occur Reiner[4b] actually worked out a mathematical treatment for cases in which an inhibitor effects potentiation by interacting with a second inhibitory substance present in the reaction mixture. Complex formation between flavin adenine dinucleotide and chlorpromazine is chemically also conceivable by means of charge effects between the pyrophosphate moiety of the flavin adenine dinucleotide and a basic function (or functions) of the chlorpromazine molecule within some *p*H ranges

In order to compare the effect of flavin adenine dinucleotide upon the inhibition of *d*-amino-acid oxidase by chlorpromazine prior and subsequent to pre-incubation, we ran a series of experiments summarized in Table 3 It is interesting that, when

Table 2 COMPARATIVE EFFECTS OF CHLORPROMAZINE AND NICOTINIC ACID UPON ISOLATED *d*-AMINO-ACID OXIDASE SYSTEMS

(1 × *d*-amino-acid oxidase and 1 × 10^{-1} *M* *dl*-alanine)

Buffer (*M*) and *p*H	Pre-incubation period at 37° C prior to reaction in minutes													
	Chlorpromazine (1 × 10^{-3} *M*)								Nicotinic acid (1 × 10^{-3} *M*)					
	45				0				45			0		
	FAD (*M*)	V_e	I%	P%	FAD (*M*)	V_e	I%	P%	FAD (*M*)	V_e	I%	FAD (*M*)	V_e	I%
Pyrophosphate (0 025) 7 92–7 93	B L* + 7 70 × 10^{-6}	202	—	8	B L + 1 00 × 10^{-5}	199	—	18	B L + 1 38 × 10^{-5}	200	33	B L + 1 00 × 10^{-5}	199	30
,,	B L	164	5	—	B L	179	—	3	B L	162	31	B L	179	29
Phosphate (0 05) 6 84–6 88	B L	60	40	—	B L	70	—	4	B L	60	37	B L	70	39
,,	B L + 7 58 × 10^{-6}	118†	–	5	B L + 2 00 × 10^{-5}	130	—	27	B L + 8 04 × 10^{-6}	118†	52	B L + 2 00 × 10^{-5}	130	42

* B L = base level (estimated 1 × 10^{-7} *M*)
† 7 29 × 10^{-6} *M* flavin adenine dinucleotide in V_e

Table 3 EFFECT OF FLAVIN ADENINE DINUCLEOTIDE UPON CHLORPROMAZINE INHIBITION OF *d*-AMINO-ACID OXIDASE PRIOR AND SUBSEQUENT TO PRE-INCUBATION

(1 × *d*-amino-acid oxidase and 1 × 10^{-1} *M* *dl*-alanine)

Buffer (*M*) and *p*H	Arrangement of reactants during the 45 min pre-incubation period at 37° C						
	Main comp enzyme, coenzyme and inhibitor, comb vol 2 68 ml Side-arm Substrate, comb vol 0 40 ml				Main comp coenzyme and substrate , comb vol 2 43 ml Side-arm enzyme and inhibitor, comb vol 0 65 ml		
	FAD (*M*)	V_e	I per cent	P per cent	FAD (*M*)	V_e	I per cent
Pyrophosphate (0 025) 7 93–7 99	B L* + 7 70 × 10^{-6}	202	—	8	B L + 6 54 × 10^{-4}	201	23
,,	B L	164	5	—	B L	175	25
Phosphate (0 05) 6 84–6 88	B L	60	40	—	B L	65	62
,,	B L + 7 58 × 10^{-6}	118†	—	5	B L + 6 54 × 10^{-4}	107	65

* B L = base level (estimated 1 × 10^{-7} *M*)
† 7 29 × 10^{-6} *M* flavin adenine dinucleotide in V_e

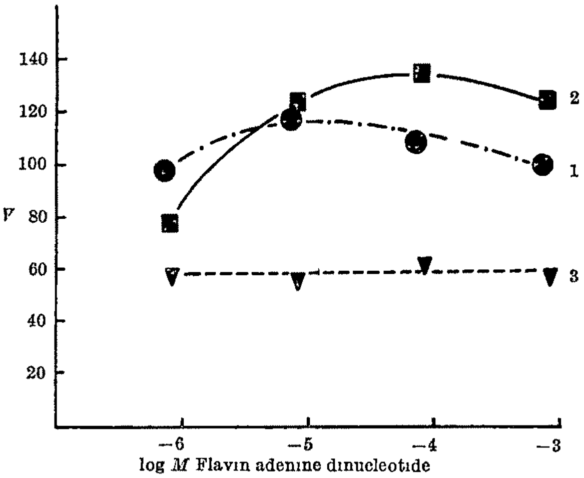

Fig 2 Comparative effects of chlorpromazine and nicotinic acid in phosphate-buffered systems (procedure 1) Common 1×10^{-1} *M* *dl*-alanine, base-level flavin adenine dinucleotide (estimated at 1×10^{-7} *M*), 1 × *d*-amino-acid oxidase, 0 05 *M* phosphate, *p*H 6 88 Curve 1, plus $7\ 27 \times 10^{-7}$ to $7\ 27 \times 10^{-4}$ *M* flavin adenine dinucleotide Curve 2, plus $7\ 58 \times 10^{-7}$ to $7\ 58 \times 10^{-4}$ *M* flavin adenine dinucleotide and 1×10^{-3} *M* chlorpromazine Curve 3, plus $8\ 04 \times 10^{-7}$ to $8\ 04 \times 10^{-4}$ *M* flavin adenine dinucleotide and 1×10^{-3} *M* nicotinic acid

excess flavin adenine dinucleotide was combined with the enzyme-inhibitor mixture subsequent to pre-incubation (procedure 2), the coenzyme would not reverse or even decrease the inhibition, yet the flavin adenine dinucleotide content of the final reaction mixture was about a hundred times that which effectively counteracted inhibition when the coenzyme was pre-incubated with the enzyme-inhibitor mixture (procedure 1) (The small volume for the pre-incubation of the enzyme-inhibitor mixture in procedure 2 was chosen to effect significant inhibition in the pyrophosphate-buffered experiments)

The information at hand indicates that formation of the enzyme-chlorpromazine complex proceeds through a relatively slow reaction, and that once the complex has formed, it is not easily reversible One could visualize a limited structural analogy between the N-alkyl substituted phenothiazine moiety of chlorpromazine and the N-ribityl substituted *iso*alloxazine component of flavin adenine dinucleotide, which may account for both (1) the stability of the chlorpromazine-enzyme complex and (2) the preferential affinity of the *free* apoenzyme for flavin adenine dinucleotide

In comparative experiments with nicotinic acid, which is known to effect inhibition by reversible competition with *d*-alanine for the combined apo- and co-enzyme[7], the chlorpromazine inhibition was approximately of the same magnitude as that of the reference reagent (procedure 1, phosphate buffer, *p*H 6 88) The nicotinic acid inhibition, however, was not affected significantly by the type of buffer, concentration of flavin adenine dinucleotide or pre-incubation (see Table 2, and Fig 2)

In conclusion, it should be noted that reserpine, Hoffmann-LaRoche's *Ro*-1-9569/7, *d*-lysergic acid diethylamide and cocaine had no significant effects upon *d*-amino-acid oxidase systems (procedure 1) optimal for chlorpromazine inhibition

We gratefully acknowledge the valuable suggestions of Drs John M Reiner and James A Bain

This investigation is supported by U S Public Health Service Research Grant No *M*-2072 from the National Institute of Mental Health

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EQUILIBRIUM CONSTANT OF THE GALACTOKINASE REACTION AND FREE ENERGY OF HYDROLYSIS OF ADENOSINE TRIPHOSPHATE

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THE adenosine triphosphate–adenosine diphosphate system appears to be a universal component of living cells, and is required for activation and utilization of most metabolites A reliable estimate of the free-energy change for hydrolysis of adenosine triphosphate is therefore needed for evaluation of the energetics of the processes concerned with cell growth and maintenance Early estimates, based on thermal data and some equilibrium constants, indicated that the standard free-energy change ($\Delta G'$) for the reaction

$$\begin{matrix}\text{adenosine}\\\text{triphosphate}\end{matrix} + \text{water} \rightarrow \begin{matrix}\text{adenosine}\\\text{diphosphate}\end{matrix} + \text{orthophosphate} \quad (1)$$

was between -9 and -12 kcal /mole at *p*H 7 (ref 1). More recently, the free-energy change for this reaction has been calculated from the equilibrium constants of a number of phosphoryl transfer reactions and less negative values (-5 to -8 kcal /mole at *p*H 7) have been reported[2-4] The discrepancies between published values are due chiefly to the difficulty of accurately determining the equilibrium concentrations of the minor components of reactions for which the change of free energy is large

The free-energy change of reaction (1) may be obtained as the sum of the free energies of phosphoryl transfers from adenosine triphosphate to hexoses, and from hexose phosphates to water Previous workers[2,3] have used the reactions catalysed by hexokinase, that is

$$\begin{matrix}\text{adenosine}\\\text{triphosphate}\end{matrix} + (\alpha+\beta)\text{-D-glucose} \rightarrow \begin{matrix}\text{adenosine}\\\text{diphosphate}\end{matrix} + (\alpha+\beta)\text{-D-glucose-6-phosphate} \quad (2)$$

and by phosphatase, that is

$$(\alpha+\beta)\text{-D-glucose-6-phosphate} + \text{water} \rightarrow (\alpha+\beta)\text{-D-glucose} + \text{orthophosphate} \quad (3)$$

However, these reactions are inconvenient because of the large free-energy change (−2 9[2] or −4 4[3] kcal/mole at pH 7) of reaction (2) For the reaction catalysed by phosphoglucomutase, that is

$$\alpha\text{-D-glucose-1-phosphate} \rightarrow (\alpha+\beta)\text{-D-glucose-6-phosphate} \quad (4)$$

the free-energy change is −1 7 kcal/mole at pH 7 and 25° C [5] It is evident that the equilibrium constant of phosphoryl transfer from adenosine triphosphate to carbon 1 of hexose may be more accurately measured than that of phosphoryl transfer to carbon 6

In the present work, the equilibrium constant of the reaction catalysed by galactokinase, that is

$$\begin{matrix}\text{adenosine}\\ \text{triphosphate}\end{matrix} + (\alpha+\beta)\text{-D-galactose} \rightarrow \begin{matrix}\text{adenosine}\\ \text{diphosphate}\end{matrix} + \alpha\text{-D-galactose-1-phosphate} \quad (5)$$

has been measured

The reaction was carried out at pH 7 0 and 25° C with 25 mM magnesium chloride, which gave an excess of Mg^{2+} at the concentrations of nucleotides used The initial reactants were adenosine triphosphate and galactose, or adenosine diphosphate and α-D-galactose-1-phosphate The course of the reaction was followed by measurement of acid or alkali uptake at pH 7 0 after addition of yeast galactokinase and muscle adenylate kinase The latter enzyme catalyses the reaction

$$\begin{matrix}2\ \text{adenosine}\\ \text{diphosphate}\end{matrix} \rightarrow \begin{matrix}\text{adenosine}\\ \text{triphosphate}\end{matrix} + \begin{matrix}\text{adenosine}\\ \text{monophosphate}\end{matrix} \quad (6)$$

and facilitates accurate measurement, by keeping the ratio adenosine triphosphate/adenosine diphosphate close to unity Nucleotides were estimated by specific enzymic and electrophoretic methods, hexose phosphates were measured enzymically and hexoses by enzymic and colorimetric methods[6]

As shown in Table 1, the equilibrium constant for reaction (5) in the forward direction was 25 ± 3, and in the reverse direction was 27 ± 3 In a preliminary series of six experiments (with 10 mM magnesium chloride), the equilibrium constant was 25 ± 9 The standard free-energy change of reaction (5) is therefore −1 9 ± 0 1 kcal/mole at pH 7 0 and 25° C in the presence of an excess of magnesium ions

The free-energy change of the reaction

$$\alpha\text{-D-galactose-1-phosphate} \rightarrow \alpha\text{-D-glucose-1-phosphate} \quad (7)$$

is −0 7 kcal/mole[7] This reaction involves conversion of the axial hydroxyl group at carbon 4 to an equatorial configuration, and the free-energy does not differ significantly from that of the corresponding transformation in other compounds[8,9] Hence the free energy of hydrolysis of α-D-galactose-1-phosphate and α-D-glucose-1-phosphate must be independent of the orientation of the remote hydroxyl at carbon 4 The free energy of hydrolysis of α-D-galactose-1-phosphate has therefore been estimated from the free-energy changes of reactions (3) and (4)

The equilibrium constant of reaction (3) was determined in both directions at pH 7 0 and 25° C in the presence of Mg^{2+} and purified intestinal alkaline phosphatase[10] As shown in Table 2, the free-energy change of reaction (3) is −3 3 ± 0 1 kcal/mole in these conditions This is in agreement with the value obtained by Meyerhof and Green[11] with more concentrated reactants, but is 0 7 kcal/mole more negative than the value reported by Gumodman[12]

The equilibrium constant of reaction (4) was also measured in both directions at pH 7 0 and 25° C in the presence of Mg^{2+} and purified muscle phosphoglucomutase[10] As shown in Table 3, the free-energy change of this reaction was −1 7 ± 0 1 kcal/mole Colowick and Sutherland[5] also obtained a value of −1 7 kcal/mole for this reaction

For the hydrolysis of α-D-galactose-1-phosphate, that is

$$\alpha\text{-D-galactose-1-phosphate} + \text{water} \rightarrow (\alpha+\beta)\text{-D-galactose} + \text{orthophosphate} \quad (8)$$

the free-energy change at pH 7 0 and 25° C in the presence of an excess of Mg^{2+} is therefore −5 0 kcal/mole

From this value, and the free-energy change of reaction (5), the free energy of hydrolysis of adenosine

Table 1 EQUILIBRIUM CONSTANT OF REACTION (5) CATALYSED BY GALACTOKINASE (ref 6)

Initial reactants	Concentration (mM) of products at pH 7 0, 25° C and 25 mM Mg^{2+}*				K†	$\Delta G'$‡ (kcal/mole)
	Galactose	Galactose-1-phosphate	ATP	ADP		
ATP and galactose	1 2 ± 0 1 (8)	11 6 ± 0 1 (8)	1 06 ± 0 02 (4)	2 78 ± 0 03 (4)	25 ± 3	−1 9 ± 0 1
ADP and α-D-galactose-1-phosphate	0 37 ± 0 04 (8)	6 1 ± 0 1 (8)	1 51 ± 0 04 (4)	2 49 ± 0 01 (4)	27 ± 3	−1 9 ± 0 1

* Results given as mean ± S E, with the number of determinations in parentheses

† $K = \dfrac{[\text{ADP}]\,[\alpha\text{-D-galactose-1-phosphate}]}{[\text{ATP}]\,[(\alpha+\beta)\text{-D-galactose}]}$

‡ $\Delta G' = -RT\ln K$

Table 2 EQUILIBRIUM CONSTANT OF REACTION (3) CATALYSED BY PHOSPHATASE (ref 10)

Initial reactants	Concentrations (mM) of products at pH 7 0, 25° C				K*	$\Delta G'$ (kcal/mole)
	Orthophosphate	Glucose	Glucose-6-phosphate	Mg^{2+}		
Glucose and orthophosphate	163	151	0 074	0	332	−3 5
	248	214	0 200	2	266	−3 3
	246	239	0 225	5	261	−3 3
Glucose and orthophosphate and glucose-6-phosphate (approx 1 mM)	240	248	0 33	2	181	−3 1
	167	253	0 156	2	271	−3 3

* $K = \dfrac{[(\alpha+\beta)\text{-D-glucose}]\,[\text{orthophosphate}]}{[(\alpha+\beta)\text{-D-glucose-6-phosphate}]}$

Table 3 EQUILIBRIUM CONSTANT OF REACTION (4) CATALYSED BY PHOSPHOGLUCOMUTASE (ref 10)

Initial reactants	Concentrations (mM) of products at pH 7 0, 25° C and 25 mM Mg^{2+}		K*	$\Delta G'$ (kcal / mole)
	($\alpha+\beta$)-D-glucose-6-phosphate	α-D-glucose-1-phosphate		
Glucose-6-phosphate	13 6	0 77	18	−1 7
Glucose-1-phosphate	12 6	0 90	14	−1 6
Glucose-6-phosphate and glucose-1-phosphate	2 09	0 11	19	−1 7

$$*K = \frac{[(\alpha+\beta)\text{-D-glucose-6-phosphate}]}{[\alpha\text{-D-glucose-1-phosphate}]}$$

triphosphate at pH 7 0 and 25° C in the presence of an excess of Mg^{2+} is −6 9 kcal /mole The standard error for this value is probably less than 0 2 kcal / mole

Benzinger, Kitzinger, Hems and Burton[4] have recently determined the free-energy change for the hydrolysis of glutamine, that is

$$\text{glutamine} + \text{water} \rightarrow \text{glutamate} + \text{ammonia} \quad (9)$$

Combination of their value with estimates by other workers[13,14] of the free-energy change of the reaction

$$\begin{matrix}\text{adenosine}\\ \text{triphosphate}\end{matrix} + \text{ammonia} + \text{glutamate} \rightarrow \begin{matrix}\text{adenosine}\\ \text{diphosphate}\end{matrix} + \text{glutamine} \quad (10)$$

indicates that the free-energy change of reaction (1) is −6 8 kcal /mole at pH 7 0 and 25° C in the presence of an excess of Mg^{2+}

By combination of the free-energy change of reaction (3) as reported here (−3 3 kcal /mole) and the free-energy change of reaction (2) as estimated by Robbins and Boyer[3], and by Vladimirov, Vlassova, Kolotilova, Lyzlova and Panteleyeva[2], the estimates of the free-energy change of reaction (1) at pH 7 0 and 25° C in the presence of an excess of Mg^{2+} are −7 7 kcal /mole and −6 2 kcal /mole, respectively

Biological phosphoryl transfers take place in the presence of Mg^{2+} and hence the free-energy values reported here are more relevant for energetics of physiological processes than the much more negative values obtained in the absence of Mg^{2+}

The free energies of phosphoryl transfers from adenosine triphosphate to many other metabolites are known By combining these values with the value of the free energy of hydrolysis of adenosine triphosphate established here, reliable estimates of the free energies of hydrolysis of most phosphorylated metabolites have now been obtained[15,16]

A full account of the work described here will be submitted for publication elsewhere[6,10,16] We wish to thank Dr R M Burton, Washington University, St Louis, for generously supplying the purified galactokinase used in these studies

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COMPLEMENTATION AMONG THE SUB-GENIC MUTANTS IN THE *r*-LOCUS OF *DROSOPHILA MELANOGASTER*

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THE composite nature of the gene, both as regards structure and function, has been admirably demonstrated by Benzer's[1] work on the *r*-II locus of the T_4 bacteriophage That complex genes are of widespread (if not universal) occurrence has also been demonstrated by the discovery of pseudoallelic series in a great diversity of organisms *Aspergillus*[2], *Neurospora*[3], and *Drosophila*[2,4] The description of the various attributes of a gene naturally necessitated a new terminology, which has now been adequately formulated by Benzer[1] He differentiated between the unit of recombination the 'recon', the unit of mutation the 'muton', and the unit of function the 'cistron' Two mutants within a locus are assigned to the same cistron if they express the mutant phenotype in the *trans* position, that is, when occurring in repulsion on the homologous chromosomes The corollary to this situation is the *cis* arrangement when the two mutants are in coupling on a member of a pair of homologues, with the non-mutant allelomorphs on the other, and this exhibits the 'normal' or wild-type phenotype Applied to *Drosophila*, this terminology means that a pair of pseudoallelic mutants occur in the same cistron if they give an interaction phenotype (that is, exhibit the mutation) in the F_1 heterozygote Conversely, the interallelic mutants are in different cistrons if they give complementation in the F_1, expressing the wild-type phenotype Inter-allelic complementation has been discovered in *Drosophila* at the *rudimentary* locus, and this phenomenon will be analysed in this communication

Induction of the Mutants

In the course of our work[5] on the induction of sex-linked recessive visibles by radiation, as well as a

Table 1 DISTRIBUTION OF THE MUTANT TYPES AND THE AFFECTED CISTRONS UNDER VARIOUS MUTAGENS

Cistrons	I	I + II	II + III	III	IV + V	V	VI	I – IV	I – VI	Total
Mutant types	*a*	*e*	*g*	*b*	*f*	*c*	*d*	*h*	*i*	
Mutagens										
Amino-acid mustards (*CB* 1592, 3007, 3025, 3026)	1	1	1	1	—	1	1	—	3	9
Alkyl methanesulphonates (*CB* 1506, 1522, 1528, 1540, 2041)	—	—	—	—	1	4	1	1	7	14
Phenylethylamine mustard (*CB* 3034)	—	—	—	—	—	1	—	—	2	3
X-rays	—	—	—	—	—	—	2	—	2	4
Stock *r* (spontaneous)	—	—	—	—	—	1	—	—	—	1
Total	4				27					31

diversity of alkylating mutagens (chloroethylamines, polyethyleneimines, and methanesulphonic esters), a total of 68 mutants at the *rudimentary* (*r*) locus were recovered. Of these, 31 mutants were retained for the inter-allelic tests. A few of the mutants analysed were induced by X-radiation, the remainder were induced by various alkylating compounds (Table 1). These compounds, together with their Chester Beatty (*CB*) code numbers and chemical names, will be listed here under their appropriate chemical series.

Amino-acid mustards: *CB* 1592, S-2-chloroethylcysteine, *CB* 3007, 3025 and 3026, the DL-, the L-, and D- isomers of *p*-NN-di-(2-chloroethyl)aminophenylalanine.

Phenylethylamine mustard: *CB* 3034, *p*-NN-di-(2-chloroethyl)aminophenylethylamine.

Alkyl methanesulphonates: *CB* 1506, 2-chloroethyl methanesulphonate, *CB* 1522, 2-fluorethyl methanesulphonate, *CB* 1528 ethyl methanesulphonate, *CB* 1540, methyl methanesulphonate, *CB* 2041, 1 : 4-dimethanesulphonoxybutane.

Phenotypically, all the *r* mutants were fairly comparable, and in general they resembled the stock visible which has already been described in the literature[6]. The hemizygous *r* males, as well as the homozygous females, were characterized by short obliquely truncated wings, with sparse costal bristles. When allelism tests were undertaken between the various mutants, however, it became apparent that we were dealing with a pseudo-allelic series, probably involving several functional sub-units (cistrons). Some of the mutants gave the *r* phenotype in the heterozygote, while others resulted in full complementation, giving the wild type.

The Complementation Map

Extensive analysis was undertaken of the phenotypic expression of crosses involving 31 *r*-alleles, and this enabled the construction of the complementation map illustrated in Fig. 1. It was possible to arrange the mutants in a unique linear sequence involving different or adjacent cistrons. In the construction of this map, mutants which complemented were assigned to different functional units (cistrons). Thus mutants *a*, *b*, *c* and *d* (Fig. 1) complement in pairs and, therefore, belong to different cistrons. This fact by itself, however, does not permit any determination of the sequence of the affected sub-genes. The detection of the intra-locus linear organization is made possible through the presence of mutants resulting from multiple 'inactivations' (or damage), extending over more than one cistron. For example, mutant *e* interacts with *a*, but complements *b*, while *h* interacts with *a* and *b*, but complements *c*. This fixes the position of *b* between *a* and *c*.

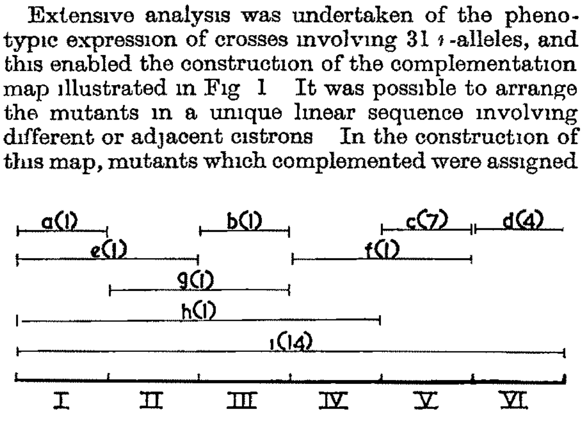

Fig. 1. Complementation map of the *r*-locus. The number of mutants in each category is indicated in brackets

The whole of the complementation map suggests the presence of at least 6-cistrons in the *r*-locus (Fig. 1). The majority of the mutants seem to involve more than one functional unit. Nearly half (14 out of the tested 31) are of the *i* type, involving all the 6-cistrons, and giving non-complementation to all other mutational types. These were at first thought to be small deficiencies at the *r*-locus. Careful cytological analysis of a non-complementing mutant (of the *i* type), however, failed to reveal even a single band deficiency in the salivary X-chromosome. According to the accepted criteria in *Drosophila* cytogenetics, therefore, even the multiple-cistron *r*-mutants must be looked upon as intra-genic point mutations. It is of interest to note that in *Neurospora*, as in *Drosophila*, non-complementing inter-allelic mutants were frequent, and did not prove to be the consequence of deletions[7]. Some of these mutants at the *al*-4 locus of *Neurospora* underwent reversion by back-mutation, and afterwards yielded secondary forward mutants of the complementing types.

A phenotypic manifestation which has some bearing on the complementation map is the appearance of the costal wing-setæ, or marginal bristles. In some inter-mutant heterozygotes the phenotype is wild-type, except for the derangement and sparsity of the marginal wing bristles. This suggested a situation of 'partial' complementation, which was designated ($r^{+}b$) indicating an intermediate state between interaction giving the (*r*) phenotype and full complementation giving the (r^{+}), or wild-type expression. If this is so, it would be expected that the ($r^{+}b$) effect should have some bearing on the complementation relations between mutants, giving some indication of the proximity of the complementing types. Table 2 gives the F_1 phenotypic expression of crosses between complementing mutants in relation to the inter-mutant distance in terms of functional units (cistrons). It is convincingly clear that the proportion of ($r^{+}b$) decreases with the distance between the mutants, and completely disappears for alleles 3 or more cistrons apart. It is therefore certain that the ($r^{+}b$) phenotype is an indicator of proximity among the complementing mutants. In

Table 2 THE EXPRESSION OF THE 'BRISTLE-EFFECT' (r^+b) IN 92 INTER-ALLELIC CROSSES BETWEEN COMPLEMENTING r-MUTANTS IN RELATION TO INTER-MUTANT DISTANCE IN CISTRONS

Distance (in cistrons)	(r^+)	(r^+b)	Total	Proportion (r^+b)
0	23	19	42	0 45
1	13	6	19	0 32
2	12	4	16	0 25
3	11	0	11	0 00
4	4	0	4	0 00

fact it is on the basis of this criterion that mutant type *d* has been placed nearest to *c* (Fig 1). This is because crosses between *c*- and *d*-mutants give the (r^+b) phenotype with the frequency expected for mutations affecting nearby cistrons On the other hand, crosses of mutants *d* × *a* and *d* × *e* all gave full complementation

The sample of *r*-mutants tested is much too small to permit an analysis of the distribution of the affected cistrons under individual mutagens Nevertheless, when mutations by groups of related compounds are considered, certain suggestive tendencies become apparent (Table 1) The mutants under the amino-acid mustards seem to form a class of their own, appreciably distinct from the rest of the sample induced by the other agents The small mutants (involving 1 or 2 cistrons) in the amino-acid mustard class show a larger scatter among the cistrons of the locus In particular, 4 out of the 9 mutants in this class involved cistrons I to III, while none of the 22 mutants by all the other agents involved these cistrons individually, or in pairs On the contrary, small mutations by agents other than the amino-acid mustards seem to occur exclusively in cistrons IV–VI Even with the small samples of mutants available, a comparison of the above relative frequencies (that is, 4/9 compared to 0/22) did indicate a difference of decisive statistical significance ($P < 0\ 01$) The lack of small mutants in cistrons I–III in the sulphonate sample as compared to that of the amino-acid mustards (that is, 0/14 compared to 4/9) also indicated a suggestively high difference ($P < 0\ 05$) There is, therefore, some indication of a difference in the mode of action of the amino-acid mustards and the sulphonates on the sub-genic level, which recalls that which has been demonstrated on the genic level[5] Experiments are now in progress to test the reality, and the degree, of the differential action on the *r*-cistrons under the effect of an individual compound belonging to each of the mutagenically contrasting chemical series · the amino-acid mustards and the sulphonates

Mechanism and Significance of Allelic Complementation

Intra-genic complementation is a fairly widespread phenomenon in micro-organisms The best-known examples occur at the *ad*-4[7,8] and *arg*-2[9] loci of *Neurospora*, but instances have also been reported in *Aspergillus*[10], as well as in *Salmonella*[11] The physiological mechanism of complementation has now been adequately analysed[7,8] for the *ad*-4 locus of *Neurospora* Extensive quantitative measurements of adenylosuccinase activity in complementing heterocaryons indicated that this activity ranges from 1 to 25 per cent that found in the parental strain Further, a correlation existed between enzymatic activity and the distance between the mutants on the complementation map Activity was maximal (that is, 25 per cent) for mutants separated by 4–6 cistrons, and fell gradually for nearer mutants, reaching a minimum when the damage occurred at juxtaposed cistrons This biochemical situation in *Neurospora* is parallel to the phenotypic 'bristle-effect' occurring among some of the complementing *r*-mutants in *Drosophila*, and suggests an analogous physiological mechanism It would seem likely that the (r^+b) phenotype is the outcome of a weak production of the r^+ 'determinant' (presumably an enzymatic complex), and that the amount of this 'determinant' increases with the distance between the damaged sub-loci in the heterozygote The disappearance of the 'bristle-effect' when the damaged sub-units are 3 or more cistrons apart indicates that this is the minimal distance (in physiological units) which is needed before enough 'r^+ determinant' is produced to manifest the wild-type expression It would be fascinating to determine the minimal distance for full phenotypic complementation in terms of physical entities (nucleotides) as well as in genetical (cross-over) units So far, this has not been achieved either in *Neurospora* or in *Drosophila* That this is within the scope of genetical techniques is indicated by some recent results[12] on the *pan*-2 locus of *Neurospora*, which show a correlation between order on the complementation map and the genetic distance in cross-over units The analysis of the genetic map of the *r*-locus in *Drosophila* is now under investigation

The complementation map here described for the *r*-locus of *Drosophila* is the first instance of this phenomenon discovered in higher organisms Evidence of intra-locus complementation, however, has already been detected in our laboratory at two other *X*-chromosome loci *tan* (*t*) and *minutechaete* (*mch*), and doubtless it must occur in many others The occurrence of inter-allelic complementation in organisms ranging from bacteria to *Drosophila* emphasizes that it is a fundamental characteristic of gene structure and function It implies that the linear sequence of the hereditary units is not only applicable to the arrangement of genes on chromosomes, but also is probably equally true of the ultimate organization of the genic substructure in terms of cistrons and nucleotides

We wish to thank Mr J Maynard-Smith (University College, London) for his interest in this problem, and also for his helpful discussion

This investigation has been supported by grants to the Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U S Public Health Service

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[8] Woodward, D O , Partridge, C W H , and Giles, N H , *Proc U S Nat Acad Sci* , **44** 1237 (1958)

[9] Catcheside, D G , and Overton, A , Symp Quant Biol , **23**, 137 (1958)

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[11] Hartman, P E Hartman, Z , Serman, D , and Loper, J C , Proc Tenth Int Congr Genet , **2** 115 (1958)

[12] Case, M E , and Giles, N H , Symp Quant Biol , **23**, 119 (1958)

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, December 29

Radar and Electronics Association (at the Royal Society of Arts, John Adam Street, Adelphi, London, W C 2), at 7 30 p m —Dr K R Sturley "High Quality Sound Broadcasting" *

Wednesday, December 30

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 2 30 p m —Dr J D Carthy "Animal Senses and Reactions" (First of two Juvenile Lectures Further lecture on January 6)

Institution of Electrical Engineers (at Savoy Place, London, W C 2), at 3 p m —Mr G G Gouriet 'Colour Television" (Christmas Holiday Lecture To be repeated on Thursday, December 31)

Friday, January 1

Plastics Institute (in the Lecture Theatre of the Institution of Electrical Engineers, Savoy Place, London, W C 2), at 2 30 p m —Dr N A de Bruyne "Sticky Plastics" (Sixth Lecture for Young People)

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturer (preferably with an interest in the theory of machines, mechanical servomechanisms or the strength of materials) in Mechanical Engineering—The Secretary, The Queen's University, Belfast (January 1)

Senior Lecturer in Clinical Biochemistry at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (January 4)

Senior Lecturer (with an honours degree and, preferably, a higher degree in electrical engineering, with specialization in electronics) in Electrical Engineering—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1, or The Registrar, University of Queensland Brisbane, Queensland, Australia (Australia and London, January 15)

Lecturer in Biochemistry in the Department of Surgery to work on problems related to the formation of pre-collagen and collagen in wound healing—Joint Clerk to the University Court, Queen's College (University of St Andrews), Dundee (January 16)

Lecturer/Senior Lecturer in Nutrition to undertake teaching and research in livestock nutrition in the Department of Nutrition and Chemical Pathology, Faculty of Rural Science, University of New England, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, January 20)

Assistant Lecturer in Statistics, to teach theoretical statistics and some mathematics—The Secretary, The London School of Economics and Political Science, Houghton Street, Aldwych, London, W C 2 (January 22)

Babcock and Wilcox Fellow in Nuclear Engineering—The Registrar, Queen Mary College (University of London), Mile End Road, London, E 1 (January 30)

Coal Petrologist (graduate majoring in geology or with equivalent qualifications, and considerable experience in the field of coal petrology) in the Coal Research Section, Commonwealth Scientific and Industrial Research Organization, Sydney, New South Wales, Australia, to carry out investigations on the microscopy of coals and cokes—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting Appointment No 480/324 (January 30)

Senior Tutor-Demonstrator in Physics at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, January 30)

Senior Lecturer/Lecturer in Chemical and Extraction Metallurgy at the University of New South Wales, Australia—The Agent General for New South Wales, 56–57 Strand, London, W C 2 (Australia, January 31)

Lecturer or Assistant Lecturer (with a special interest in climatology and/or biogeography and prepared to take part in the teaching of practical cartography) in Geography—The Secretary and Registrar, The University, Southampton (February 1)

Lecturer or Assistant Lecturer (with a special interest in some aspect of systematic botany, preferably in experimental taxonomy of vascular plants or paleobotany) in Botany—The Secretary and Registrar, The University, Southampton (February 1)

Lecturer (with a good university degree and experienced in the teaching of physics and/or mathematics in schools) in Education—The Secretary and Registrar, The University, Southampton (February 1)

Chair of Physiology in the London Hospital Medical College —The Academic Registrar, University of London, Senate House, London, W C 1 (February 1)

Imperial Chemical Industries Research Fellows in Physics, Chemistry, Biochemistry, Engineering, Metallurgy and Pharmacology—The Registrar, The University, Liverpool (February 13)

Junior Lecturers (2) in Mathematics—Prof E C Titchmarsh, Mathematical Institute, The University, Oxford (February 20)

Entomologist (with a good honours degree in zoology or entomology, and preferably postgraduate research experience in forest or timber entomology) with the West African Timber Borer Research Unit, Kumasi, Ghana, to undertake studies of the biology, ecology and control of timber and lumber pests—The Director of Recruitment, Colonial Office, London, S W 1, quoting BCD 197/510/01T

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Pharmaceutical Legislation in Great Britain By Allan Duckworth (Paper presented at the International Congress on the Problems of European Pharmaceutical Legislation, held under the auspices of the Italian Society of Pharmaceutical Science, Rome, May 4–6, 1959) Pp 23 (London Association of British Pharmaceutical Industry, 1959) [3010

Becoming a Teacher Pp 8 (London Ministry of Education, 1959) [411

Imperial College of Science and Technology (University of London) Prospectus 1960–61 Pp viii+56+4 plates Calendar, 1959–60 Pp xi+378 (London Imperial College of Science and Technology, 1959) [411

The Hampstead Scientific Society Report and Record for 1953 to 1959, With a List of Members Pp 24 (London Hampstead Scientific Society, 1959) [411

Annual Report on the Meteorological Office for the year April 1, 1958, to March 31, 1959 Pp 51+5 plates (M O 659) (London H M Stationery Office, 1959) 3*s* 6*d* net [411

Great Britain and Ireland

United States Department of the Interior Geological Survey Water-Supply Paper 1370-C Summary of Floods in the United States during 1954 Prepared under the direction of J V B Wells Pp vii+201–263+plates 2–5 30 cents Water-Supply Paper 1375 Ground-Water Resources of Riverton Irrigation Project Area, Wyoming By Morris O M Hackett, K E Vanlier and E A Moulder With a section on Chemical Quality of Ground Water by W H Durum Pp vi+205+6 plates Water-Supply Paper 1402 Quality of Surface Waters of the United States, 1955 Parts 7 and 8 Lower Mississippi River Basin and Western Gulf of Mexico Basins Prepared under the directon of S K Love Pp x+539 1 75 dollars Professional Paper 306-B Geology and Paleontology of Canal Zone and Adjoining Parts of Panama—Description of Tertiary Mollusks (Gastropods Vermetidae to Thaididae) By W P Woodring Pp iii+147–239+plates 24–38 Professional Paper 314-H Pre-Atoka Rocks of Northern Arkansas By Sherwood E Frezon and Ernest E Glick Pp iii+171–189+plates 20–31 Professional Paper 315-B Geology of part of the Horseshoe Atoll in Borden and Howard Counties, Texas By R J Burnside Pp iii+21–35+plates 10–14 (Washington, D C Government Printing Office, 1959) [3010

United States Department of the Interior Geological Survey Water-Supply Paper 1422 Geology and Ground-Water Resources of Medina County, Texas By C L R Holt, Jr Pp vi+213+plates 1–6 Water-Supply Paper 1432 Surface Water Supply of the United States, 1956 Part 1-B North Atlantic Slope Basins, New York to York River Prepared under the direction of J V B Wells Pp xii+627 2 dollars Water-Supply Paper 1508 Surface Water Supply of the United States, 1957 Part 5 Hudson Bay and Upper Mississippi River Basins Prepared under the direction of J V B Wells Pp xii+624 2 dollars Water Supply Paper 1512 Surface Water Supply of the United States, 1957 Part 8 Western Gulf of Mexico Basins Prepared under the direction of J V B Wells Pp x+536 1 75 dollars Water-Supply Paper 1517 Surface Water Supply of the United States, 1957 Part 13 Snake River Basin Prepared under the direction of J V B Wells Pp viii+261 1 dollar (Washington, D C Government Printing Office, 1959) [3010

Indian Forest Records (New Series) Timber Mechanics Vol 1, No 6 Physical and Mechanical Properties of Woods Tested at the Forest Research Institute, Report V By A C Sekhar and S S Bhatnagar Pp 123–135 Rs 1 25, 2*s* Indian Forest Bulletin (New Series) Entomology No 221 Clump-Curing of Bamboos and Susceptibility to Powder-Post Beetle Attack By Dr R N Mathur Pp 19 Rs 2 25, 3*s* 9*d* Indian Forest Records (New Series) Timber Mechanics Vol 1, No 7 Physical and Mechanical Properties of Woods Tested at the Forest Research Institute, Report VI By A C Sekhar and D N Bhatia Pp ii+137–146 Rs 1, 1*s* 6*d* Vol 1, No 8 Physical and Mechanical Properties of Woods Tested at the Forest Research Institute, Report VII By A C Sekhar, B R Sen and S S Bhatnagar Pp 147–154 Rs 0 87, 1*s* 3*d* (Delhi Manager of Publications, 1957 and 1958) [3010

Some Aspects of Food Technology in India Edited by H A B Parpia, R C Bhutiani, K L Radhakrishnan, A N Sankaran and B V Subbarayappa (Specially brought out on the occasion of the FAO Regional Seminar on Food Technology for Asia and the Far East, August 1–8, 1959) Pp viii+160 (Mysore Central Food Technological Research Institute, 1959) [3010

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO , LTD ,
ST MARTIN'S STREET, LONDON, W C 2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare London

Annual subscription £7/15/–, payable in advance,
postage paid to any part of the world

Advertisements only should be addressed to
T G Scott & Son, Ltd , 1 Clement's Inn, London, W C 2
Telephone Number Holborn 4743

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SCIENTIFIC MAN-POWER PROBLEMS IN BRITAIN

THREE years ago, in October 1956, the Scientific Man-power Committee of the Advisory Council on Scientific Policy issued a report on scientific and engineering man-power in Britain, based on information collected from Government departments, including a survey carried out by the Ministry of Labour, with the help of the Social Survey, of all manufacturing establishments employing 500 workers or more, and on a sample of those employing between 100 and 499 A report now issued by the same Committee (see p 1982 of this issue of *Nature*) gives information about the numbers and employment of scientists and engineers in Great Britain at the beginning of 1959 and the changes which have occurred since 1956, including a review of forecasts by employers of their demand for scientists and engineers by 1962 This is based on information collected by the Ministry of Labour and National Service in the first three months of 1959 No attempt is made to re-assess the long-term demand as forecast in the earlier report, but an estimate is made of the number of scientists and engineers who will qualify during the next three years, and the short-term relation between supply and demand is examined Neither survey includes technologists with specialist qualifications in branches of applied science such as textiles, rubber or plastics unless they are also qualified scientists or engineers as defined for the purpose of the earlier survey As in that survey, the Ministry of Labour inquiry included private industry, nationalized industry and public corporations, central and local government (excluding education and the Armed Forces) and education Together these employments account for almost 90 per cent of all qualified scientists and engineers in Great Britain

At the beginning of 1959, the inquiry indicated that about 173,000 scientists and engineers were employed in Great Britain, an increase of rather more than one-fifth on the number employed in 1956, and a third of the increase for which, it was suggested, minimum provision should be made by 1966 About 20,000 of these are engaged on defence work, including one in four on research and development in industry and government establishments, and there is evidence that the proportion engaged on defence work has fallen during the past three years Between 1956 and 1959 the number of scientists and engineers employed in manufacturing industry increased by about 30 per cent, although industrial production was relatively stable The increase occurred mostly in those industries which have shown some increase in output during the period, and more particularly in the newer industries which have expanded rapidly since the War, and which employ relatively larger numbers of scientists and engineers Investment during the period has been high, and about two-fifths of all scientists and engineers in industry are employed on research and development work which can be expected to show results in the longer term

According to the statements of employers, there were immediate vacancies for about 9 per cent more scientists and engineers at the beginning of 1959, and if these vacancies had been filled the total employed would have approximated closely to the forecast of requirements the employers made in 1956 There were, nevertheless, wide divergencies between forecast requirements and actual recruitment in industrial groups, while apart from unforeseen economic and technological changes, some employers were not in as strong a position as others to compete for the qualified scientists and engineers they wished to recruit While in the technical colleges the increase in the number of teachers has kept pace with the most recent estimates of demand, in the schools there has been a relatively greater increase in the number of boys and girls studying science than in the number of science teachers In the grammar schools the continued increase in the number of teachers has been just about sufficient to maintain standards of teaching science, notwithstanding the increase in the number of those studying science in the sixth forms, but many schools have had to face serious difficulties

These figures may well be considered here in detail, for the educational position is the critical factor In 1959, some 33,650 scientists and engineers were teaching in universities, technical and teacher training colleges, and schools. Omitting a group of 1,300 engineers in technical colleges and 370 teachers in independent schools, the total of 31,980 compares with 28,040 in 1956, and of these, 4,175 were teaching in the universities, 5,560 in the technical and teacher training colleges, and 22,245 in the schools While, however, the actual increase in the technical and teacher training colleges was 23 per cent compared with 14 per cent forecast, in the universities it was 28 per cent compared with 33 per cent forecast, and in the schools only 10 per cent compared with 18 per cent forecast, and an increase of 18 per cent in the number of secondary school pupils There is evidence that teachers of mathematics are scarce, while the supply of biology teachers appears to have at least kept pace with demand Nevertheless, the survey shows that the shortage of scientists is still most acute in the schools, and since the returns received from employers indicate no slackening at present in the demand for qualified scientists and engineers, the continuing shortage of suitably qualified teachers is likely to remain a matter of serious concern

Indeed, in secondary schools other than grammar schools, the growth in the number of children and the efforts now being made to develop new courses are creating new demands so rapidly that there is little or no prospect in the next three years of maintaining even current standards, although the Man-power Committee considers that the position should improve afterwards In grammar schools it concludes that the experience of the past three years is likely to be repeated over the next three The Man-power Committee does not consider the implications of any change in policy directed to ensure that a larger proportion of school leavers have at least some general acquaintance with science and its methods, and it is left for the Advisory Council on Scientific Policy in its annual report, issued simultaneously with that of the Scientific Man-power Committee, to emphasize that inadequate school education in mathematics and the physical sciences will have detrimental repercussions on the efforts being made by the universities and technical colleges to increase the output of professional scientists and engineers

The Scientific Man-power Committee, apart from a word of caution as to how far the employers' statements constitute a real basis for an estimate of future demand, does not attempt any appraisal of the total on the lines of Prof J. Jewkes's analysis in his presidential address to Section *F* (Economics) at the British Association meeting at York. The questions which Prof Jewkes asked need to be kept in mind in considering both the forecast demand for scientists and engineers by 1962 and any measures proposed to provide a sufficient supply As already noted, immediate vacancies amount to about 9 per cent of the 63,581 employed in private manufacturing industry at the beginning of 1959, and all employers together hope for an increase in numbers of 38,700 by 1962, or a total increase of 22 per cent, while a further 14,600 will be required to replace losses from retirements, deaths and migration.

In its previous report, the Man-power Committee estimated that the annual flow of qualified scientists and engineers from the universities, professional institutions and technical colleges would have to increase from just over 10,000 in 1954–55 to about 20,000 by 1970 to be compatible with the number of scientists and engineers which is thought to be required to sustain an acceptable rate of economic growth Present forecasts suggest that the number of scientists and engineers qualifying for the first time will increase from 14,600 in 1958 to 18,500, and that 47,500 newly qualified scientists and engineers will become available for employment in Great Britain during the three years 1959–61 The rate of increase during the past three years has been higher than was expected in 1956, and if it continues until 1966, the original target of 20,000 should be reached by the mid-1960's.

Nevertheless, after allowing for the replacement of wastage, the total numbers coming forward during the next three years are still likely to fall short of employers' estimates of their needs, and in particular the shortage of mathematicians, physicists and chemists is likely to continue. Of the 14,600 qualifying in 1958, about 5,700 were scientists and 8,900 engineers, and the rate of increase for engineers (from 6,800 in 1955) has been higher than for scientists (5,250 in 1955) While the Advisory Council for Scientific Policy sees no likelihood of the universities and colleges of technology training too many professional scientists and technologists, it has reservations as to particular categories, such as biology Biologists with specialized training in such fields as biochemistry or physiology are unlikely to encounter any difficulty in obtaining employment, but the average graduate in biology may well find the best opening in teaching, and the Advisory Council suggests that those who intend to study biology should be warned of the importance of supporting qualifications in mathematics or a physical science, and also of possible difficulty in obtaining posts in their subject unless they are outstanding or proceed to postgraduate training or specialization

The Advisory Council on Scientific Policy agrees with the Scientific Man-power Committee that experience of three years is an insufficient basis for detailed re-assessment of the long-term demand However, the picture presented in this report shows a welcome trend of a higher rate of growth in the employment of scientists and engineers than had been expected, and also a higher output of trained men, but there is still much work to be done before an accurate picture can be obtained Nor is this solely a matter of seeking answers to some of the questions which Prof Jewkes has raised Even if it is shown that industry's estimates and forecasts are excessively high, and that there is considerable scope for economy through the more efficient use of scientists and technologists, that could be largely offset by one aspect which is not covered by the report, although it is clearly very much in the mind of the Advisory Council on Scientific Policy, namely, the demand from overseas for British scientists and technologists

MYTH AND RITUAL

Myth and Ritual in the Ancient Near East

An Archæological and Documentary Study. By Prof E O James Pp 352 (London Thames and Hudson, Ltd , 1958) 35*s* net

DURING the past quarter of a century and more, British scholarship has played an outstanding part in the investigation of the problems of myth and ritual in the ancient Near East, as is shown by the successive symposia edited by S H Hooke, namely, "Myth and Ritual" (1932), "The Labyrinth" (1935), "Myth, Ritual and Kingship" (1958) To the third of these volumes two foreign scholars contributed, one of them a Swede, the British achievement thus being linked with the remarkable activity of Scandinavian scholars in the same field Now we have a wide-ranging study by a veteran student of religion, Prof E O James, which many will welcome as a most helpful guide through the tangled jungle of ancient religious belief and practice The author draws on the most recent archæological evidence—much of it makes very severe demands on the interpreter—from Egypt, Syria, Palestine and Mesopotamia, and from even farther afield, from the Ægean, Anatolia, Persia and Western India The notes and bibliography show how wide and thorough has been the research which lies behind this attractive volume

It is quite essential in work of this kind that careful attention should be given to the meaning of the terms used Prof James has much that is illuminating to say by way of defining the meaning of the word 'myth' Properly understood, myth is, in Malinowski's words, "a narrative resurrection of a primeval reality", which accompanies the ritual by which a body of people maintains its corporate life It has thus to be distinguished from folk-tales and *Marchen* and sagas which are told merely for purposes of entertainment, having lost their original religious function It is claimed, however, though the distinction is not made very clear, that a considerable body of myths exists apart from any ritual setting, those which we can class as ætiological, where the original ritual connexion has been forgotten or is no longer operative There are also the legends and sagas which embody the essential traditions of a people and eventually give birth to history and so are not to be classed as mere entertainment In these, myth has not yet ceased to be functional

The myths which form the subject-matter of the main inquiry are dealt with under various heads The beginnings of myth and ritual are studied with reference to the evidence of cave art and of the earliest literary sources Then follow six chapters which describe and discuss the seasonal cult drama, the sacral kingship—a subject which has rightly occupied the centre of interest in scholarly inquiry in this field —the mother-goddess and the sacred marriage, the myth and ritual of creation, good and evil and the sacred combat, and eschatological mythology Prof James follows Frankfort in recognizing that there is not identity of pattern in myth and ritual over the whole area under survey, but pleads for a fundamental similarity At the same time, he makes clear the distinctive use which Israel made of the ideas and practices which it borrowed The reader could not do better than read this book in conjunction with "Before Philosophy" by Frankfort *et al* (Pelican Books) and the first volume of Voegelin's monumental "Order and History" In much that is excellently expounded, Prof James is especially to be congratulated on his elucidation of the relation that existed between the Memphite, the Hieropolitan and other Egyptian theologies He perhaps shows more confidence than is justified in Ventris's claim to have deciphered the Minoan script Linear *B*

I have noted a few minor errors and slips On p 62 Enoch should be Enosh On p 65 the date of the fall of Samaria should be 722 and not 586, while it is scarcely correct to equate *berith* and cultus On p 66, line 6, 'later' should surely be 'earlier' (cf Leviticus 23 23 ff with I Kings, 12, 32–3) On p 69 read Hekatombaion On p 122 there is something wrong in the reference to Adonis grieving for Attis On p 125 it is odd to find Aleyan-Baal described as the mother of Mot On p 147 'Atum' should surely be read 'Ptah', while on p 271, 'Agamemnon' should be 'Priam' On p 267 the third sentence (ending with 'Gibeonites') is so inaccurate that it requires radical revision On pp 272–3 there seems to be a contradiction between two statements of the view in the Iliad regarding men's responsibility for the sufferings that afflict them

NORMAN W PORTEOUS

NUCLEAR TECHNOLOGY AND THE SCHOLARLY TRADITION

The Physical Theory of Neutron Chain Reactors

By Alvin M Weinberg and Eugene P Wigner Pp xii + 801 (Chicago University of Chicago Press, London Cambridge University Press, 1958) 112*s* 6*d* net

THE Geneva Conference in 1955 released a vast amount of information on nuclear technology and stimulated the publication of a large number of books and periodicals An appreciable fraction of these were, understandably but effectively, catalogues of materials or of reactor types, facts were paramount and reasons somewhat neglected Authors and teachers now have, as one of their tasks, to select from a large and expanding body of facts those which demonstrate most clearly the fundamental aspects of the subject For reactor technology a notable contribution to the organization of the fundamentals has been made by Weinberg and Wigner in this book The preface states explicitly that one of their aims is to help develop a scholarly tradition in reactor technology and both authors are, of course, well equipped for the task It is not surprising that Wigner, as the distinguished holder of a chair of theoretical physics, should embark on it, but we must feel grateful that Weinberg's duties as director of a large national laboratory have left him with sufficient energy and enthusiasm to collaborate

From the beginning it is clear that the 'physical' in the title is meant to be justified and fully one-quarter of the book is concerned with nuclear physics Obviously, the authors hold the view that an uncritical extrapolation from known cross-section data is becoming more prevalent and is highly undesirable To reduce this tendency they devote several chapters to a discussion of neutron interactions in general and to the fission process in particular For the newcomer to nuclear physics some preliminary guidance in the history of nuclear models would help the process of assimilation, but no such help is needed with the chapter on fission, it is a clear and succinct presentation of the main features

After dealing with the nuclear foundations, the book turns to chain reactions and to the moderation and diffusion of neutrons The short chapter on chain reactions introduces a change in terminology from that normally used "criticality factor" takes the place of "effective multiplication factor", and a new term, "finite multiplication factor" is introduced. The latter is concerned not with neutron leakage from finite systems but with the possible dependence of quantities such as resonance escape probability and thermal utilization on the size and shape of a reactor This dependence is weak, but the discussion of it is in keeping with the rigour exhibited in many parts of the book In view of this, it is a pity that there is a slip in the section on multiplication factors where these are stated to be less, instead of greater, than the criticality constant

Diffusion and transport theories for mono-energetic neutrons, and hence for thermal neutrons once the representative velocity has been selected, are presented in two long chapters The first shows clearly the assumptions involved in the use of diffusion theory and forms a valuable introduction to the study of neutrons in bulk materials The second presents Boltzmann's equation in various mathematical forms and discusses methods of solution. Chapters on the energy spectrum during moderation and on the diffusion and thermalization of fast neutrons complete the first half of the book, and any reader well acquainted with its contents is fully equipped to embark on the study of reactor theory which follows. Here the introductory chapters are concerned with unreflected homogeneous systems, both critical and sub-critical. Non-uniform reactors and reflectors follow and provide an opportunity for the introduction of two-group analysis; multi-group methods also are mentioned briefly. Up to this point the discussion has been concerned principally with the steady state, but the emphasis changes with the introduction of perturbation theory and with the treatment of reactor kinetics. The last chapter in the book deals with the theory of control rods but, before this is reached, heterogeneous reactors receive the thorough treatment which by this stage the reader is taking almost for granted.

J. WALKER

HETEROGENEOUS CATALYSIS

Advances in Catalysis and Related Subjects

Vol. 10. Edited by D. D. Eley, W. G. Frankenburg and V. I. Komarewsky. Pp. xvi+326. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1958.) 11 dollars; 88s.

THE preparation of this tenth volume of "Advances in Catalysis" has unhappily coincided with the death of two of the founding editors, W. G. Frankenburg and V. I. Komarewsky. Tributes to them appear appropriately at the beginning of the book. By maintaining a balance between the more academic and the more technical aspects of heterogeneous catalysis, and by allowing occasional excursions into homogeneous and biological catalysis, the editors have progressively encouraged the specialist to broaden his horizon. Vol. 10 carries this tradition further and is certain to add to the wide, international readership which the series already enjoys.

For the most part, the articles follow the pattern of earlier volumes by describing the contributions to knowledge of catalysis made over the years by individual groups, the accounts being written by one or more of the authorities concerned. Three of the seven articles ("The Infra-red Spectra of Adsorbed Molecules", by R. P. Eischens and W. A. Pliskin, "The Active Surface of Cholinesterases and their Catalytic Action in Ester Hydrolysis", by F. Bergmann, and "Commercial Alkylation of Paraffins and Aromatics", by E. K. Jones) also include sufficient description of related work in other laboratories to be classified as general reviews of the subjects indicated. The remaining four articles ("The Nature of Active Centres and the Kinetics of Catalytic Dehydrogenation", by A. A. Balandin, "The Influence of Crystal Face in Catalysis", by A. T. Gwathmey and R. E. Cunningham, "The Reactivity of Oxide Surfaces", by E. R. S. Winter, and "The Structure and Activity of Metal-on-Silica Catalysts", by G. C. A. Schuit and L. L. van Reijen) are comprehensive so far as the work of the originating laboratories is concerned, but rather selective in their coverage of parallel studies conducted elsewhere.

A. A. Balandin describes both the geometric and energetic aspects of his multiplet theory and applies it to a wealth of well-documented experimental data. Since most of his original papers are in Russian, this account in English is particularly valuable. F. Bergmann gives a well-presented development of the present status of knowledge on the arrangement of the components at the cholinesterase surface and on the mechanism of enzymatic hydrolysis. R. P. Eischens and W. A. Pliskin describe their own important infra-red studies on metal–silica and oxide catalysts; they also include, among other topics, a critique of the Russian work on the spectra of adsorbed hydroxyl radicals. A. T. Gwathmey and R. E. Cunningham largely confine themselves to a descriptive, but very well-illustrated, account of the selective reactivity of certain faces of copper and nickel single crystals in oxidation and in the presence of carbon monoxide, ethylene and hydrogen–oxygen mixtures. The article by E. K. Jones describes (with a rather unnecessary amount of jargon) the sulphuric and hydrofluoric acid processes for the production of high-octane fuels and also outlines the newer developments in the petrochemicals field afforded by alkylation methods. G. C. A. Schuit and L. L. van Reijen apply fundamental thermodynamic and kinetic treatments to their thorough experimental studies of adsorption and catalysis on nickel–silica and other supported metal catalysts, and E. R. S. Winter gives a full account of his valuable research on the application of oxygen-18 and carbon-13 isotopes in studies of adsorption, catalysis and oxygen exchange at oxide surfaces.

The volume, which is well produced, will be indispensable to all laboratories where there is active research in heterogeneous catalysis.

F. S. STONE

THE GENUS *OENOTHERA*

Taxonomy and Genetics of *Oenothera*

Forty Years Study in the Cytology and Evolution of the Onagraceae. By R. Ruggles Gates. (Monographiae Biologicae, Vol. 7.) Pp. 115. (The Hague: Dr. W. Junk, 1958.) 14 guilders.

THE genus *Oenothera* has been of considerable importance in the history of genetics and cytology, and Prof. Ruggles Gates has for many years been one of the most active students of the genus. His publications concerning the evening primroses have been numerous and it is useful to have an outline of the results summarized in one volume. Cytogenetically, species of *Oenothera* differ from the majority of plants the chromosome behaviour of which has been studied in that there is "pairing of the chromosomes at their end portions only". Thus are formed ring-pairs at meiosis. In addition, the evolutionary conditions in the genus are further complicated by non-disjunction, trisomics, polyploid mutations, genetic complexes, balanced lethals, self-sterility factors, self-pollination, and dominant mutations for smaller flowers. Since catenation, combined with the presence of balanced lethals, prevents the segregation of homozygotes in the offspring of a cross, there result plants which breed true although highly heterozygous.

The author has grown and studied hundreds of cultures of *Oenothera*. The resultant taxonomy, range, and distribution are given for a number of complexes, and culture variations are considered. The evolution of the genus is divided into two periods: first, the pre-Pleistocene, during which differentiation of the large-flowered open-pollinated species such as *O hookeri*, *O grandiflora* and *O argillicola* took place by ordinary methods, the chromosomes all remaining as free pairs , secondly, the Pleistocene and especially post-Pleistocene period, during which chromosome linkage took place, followed by the production of a great number of self-pollinating forms with small flowers as the genus spread northwards after the last retreat of the ice. Thus, the method of evolution appears to have changed radically during the evolution of the genus

The value given to the very numerous taxa, recorded by Prof Ruggles Gates and others, in any taxonomic scheme can only be judged fairly by one who has made a special study of *Oenothera* and allied genera Apart from the general true-breeding character of these taxa, it is certain that many differential characters are involved and that some or other of these are shown at all stages of the life-history from the young seedling to the final phases of reproduction It is none too clear, however, as to how the author determines taxa as species, micro-species, sub-species, varieties, etc It would have been interesting to have had from him at least working definitions of such categories as he uses within the genus *Oenothera*

W B Turrill

SCIENCE AND SCEPTICISM

The Way Things Are

By Prof P W Bridgman Pp. xi+333. (Cambridge, Mass : Harvard University Press , London . Oxford University Press, 1959) 45*s*. net.

IN this remarkable compilation the author gives us his views, frequently unorthodox, on Marxism, death, integrity, psycho-analysis, taxation, freewill, Red Indian languages, martyrdom, sovereignty, faith, military service, McCarthy, the economic status of the teaching profession, and the illogicality of women. Income tax provokes Prof. Bridgman's indignation as much as anything "To me the thing that is hardest to bear is the obvious inequity of it all I do not expect my neighbour to give to me of his goods because I need them more than he does—why should society compel me to give of my goods to society because society needs them more than I do, society being only all my neighbours together ? Every time I pay my income tax I smart under a sense of unfairness as keen as that of the old militant suffragette, denied the right to vote merely because of her sex I feel exploited and discriminated against on the basis of superior ability and industry. It is hard to keep away the bitterness."

The thread of the book is difficult to find, to understand and to follow Bridgman contends that there is an "ineptness" in our thinking in the natural sciences, in psychology, and in politics This is characterized in three main ways all observations affect their subject-matter, no system can fully account for itself (Godel's theorem is mentioned here), and all knowledge is private to the perceiver

We cannot, laments Bridgman, "get away from ourselves". Even mathematical proof, he says, is a personal matter which cannot be communicated, and so mathematics is even less "objective" than chemistry or physics If this is so, it is difficult to see how mathematics can be taught Bridgman's difficulties over subjectivism and solipsism appear to rest on a confusion between the acquisition of knowledge, which is a personal matter in the sense that a particular individual must make the observation, conduct the experiment or find the proof, and what it is that is found out, which may be as "objective" or "public" as you please Some of Bridgman's discussions of concepts in the natural sciences, such as "particle" or "probability" are interesting and helpful , but there is an ineradicable crankiness about the book which, in view of the distinction of both the author and the publisher, is as surprising as it is regrettable

C K Grant

THE UNIVERSITY OF LEICESTER

New University

By Prof Jack Simmons Pp 233+16 plates. (Leicester . The University Press, 1958) 12*s*. 6*d*. net

PROF SIMMONS has made an admirable contribution to the growing library of books about the origins of modern universities. His first chapter is a neat and concise account of the widespread movement which has multiplied the undergraduate population in England by nearly fifty in less than 150 years Against that background he tells with sympathy and candour the story of the University of Leicester

It was fitting that Leicester should become a university town, for it is ancient, prosperous, trim and clean , and by the beginning of the twentieth century there existed in it strands of educational life waiting to be brought together in a university pattern But it had rivals not far distant, and it needed "the liberality, the determination and the toughness" of a small group of men to set the pattern and weave the fabric.

The usual stages are recorded Press correspondence, a local committee, outside advice, and the dramatic acquisition of a building. Then came squalls · the questions of 'federation' with Nottingham, of the local nature of the projected University College, of delay in the appointment of a principal. But on October 4, 1921, the College opened its doors to nine students and a staff of four

In the following year it "made its formal bow to the public" and began to face the problems of adolescence It had no smooth path, financial or academic, during the next fifteen years, and there was discontent, both within it and about it But progress was made, until in 1945 the University Grants Committee recognized it for assistance from the Exchequer

This was in effect a second start, and by 1950 the University College had more than 700 students with ten professors and an energetic principal Building extensions and academic developments of considerable enterprise paved the way for independence , and in 1957 the charter of the University was granted

So the last of the 'old university colleges' attained adulthood, and joined the ancient and distinguished band of institutions which grant their own degrees in full academic independence Each of the members of this band has its own distinctive flavour Prof. Simmons has put us all in his debt by his modest and fascinating chronicle of the advances and setbacks, the struggles and the victories of this sturdy new member of the university family

J F Wolfenden

Maladies of Hevea in Malaya

By Roger N Hilton With watercolours by Hoh Choo Chuan Pp 101 (Kuala Lumpur Rubber Research Institute of Malaya, 1959) 30 Malayan dollars

THE reviewer feels he should make it clear at the outset that his acquaintance with *Hevea brasiliensis* as a plantation tree is limited to Trinidad, where the climate is not wholly suited to it and where it is accordingly little grown He has therefore no personal experience of the diseases as such, though many of the fungi figured are familiar in other contexts With these limitations he feels it difficult to criticize Mr Hilton's text Mr Hoh Choo Chuan's watercolours are outstanding no less for their beauty than for their extraordinary faithfulness and precision while their reproduction is of the highest quality Anyone who has tried to record white hyphæ and mycelial strands straying over living leaves will appreciate the skill displayed in, for example, the plates of thread blight and powdery mildew

Only diseases and injuries to *Hevea* already known in Malaya are figured These include fasciation, leaf malformation, genetic yellows, chlorosis, oil spot, leaf rim blight, sun scorch, heat scorch, lightning damage, fire damage, symptoms of herbicide poisoning, waterlogging and drought, brown bast, fissures of the tapping panel and bark burrs as well as troubles associated with fungi and with *Loranthus* spp Each plate is accompanied by a page of text on which information regarding the disease is summarized under the headings symptoms, cause, other hosts and spread (where a pathogen is involved), prevention and treatment The diseases are arranged under the following headings those affecting the whole plant, the roots, the stem and branches, the tapping panel, leaves of young plants and leaves of mature plants The point of view is severely practical throughout and the work should prove a valuable handbook to the rubber planter in the eastern tropics

R W G DENNIS

Theory of Beams

The Application of the Laplace Transformation Methods to Engineering Problems By T Iwinski Translated from the Polish by E P Bernat Pp 85 (London and New York · Pergamon Press, 1958) 21*s* net

FROM the point of view of the structural engineer with mathematical inclinations this is an interesting little book and it is likely to be stimulating to advanced students The solution of beam problems in practice has, however, long since been reduced to the judicious use of tabulated information and most problems can be dealt with rapidly in this way

It is stated that this monograph is the first part of a major project on the application of the Laplace transformation method to problems in the theory of structures Solution of the differential equation of uniform beams with linear elasticity and uniform loading by means of the Laplace transformation is demonstrated followed by generalization to include the effects of concentrated forces and couples It is shown that the solution always consists of two parts . one part depends upon the support or boundary conditions while the other depends upon the system of loading By taking account of this feature it is shown that the problem of determining the deflected form of a beam can be transformed from the solution of a differential equation to the solution of simultaneous algebraic equations Finally, the solution of the differential equation of beams with variable flexural rigidity and subjected to general conditions of loading is considered

T M CHARLTON

Potassium Symposium 1957

Sixteen Papers read at the Fourth Congress of the International Potash Institute, Vienna, 1957 Pp 420+4 plates (Berne International Potash Institute, 1959) n p

THE report published by the International Potash Institute as an outcome of its congresses, held annually from 1953 to 1956, covered many aspects of broad and general interest, potassium being considered from the aspect of agricultural chemistry throughout the various phases of the plant-soil system The theme of the last congress is more particularized and the main interest is in a varied assortment of species in close association, especially herbage plants The part played by potassium in the growth of herbage plants, legumes and grasses, is a complicated matter since numerous factors are involved The importance of grassland in agriculture justifies such a restricted interest and the papers cover some important aspects of it One of the topics was the influence of potassium fertilizers on animal production from pasture, another on their influence on the cultivation of irrigated prairies in Italy, and others on their application under widely differing external conditions of moisture and temperature These titles indicate the general field of interest in the congress The paper on the production of animals and pasture grazing led to a lively discussion on grass tetany

This volume, it will be seen, is mainly of agronomic interest and in its field it provides information of real value The papers are in English, French, German and Italian, in some cases full translations being provided, and in most cases summaries in English, German, French and Italian It is lavishly produced on thick glossy paper and has illustrations, some in colour, with an author index and subject indexes in English, German, French and Italian

The Cellular Slime Molds

By Prof John Tyler Bonner (Investigations in the Biological Sciences, No. 1) Pp viii+150+8 plates (Princeton, N J Princeton University Press, London Oxford University Press, 1959) 32*s* net

PRECEDED by a brief review of the Mycetozoa, this account of the Acrasiales, taking in all published work up to 1959, is divided into three sections corresponding to the biology, morphogenesis and genetics of this group Although many of the facts and concepts are already available in review form, this new synthesis should be useful to those who have to lecture on these topics and to those wanting a source book on developmental problems in relatively simple organisms Described on the cover as a monograph, the book lacks the objectivity and balance that is looked for in this form of writing, particularly in respect of the varying emphasis given to different aspects of our knowledge, and in the conjectural nature of much of the discussion It is towards the end of the book (p 133) that the author realizes "such speculation soon becomes hollow and unrewarding"

D PARK

Land and Water Bugs of the British Isles

By Dr T R E Southwood and Dennis Leston Pp xi+436+63 plates (London and New York Frederick Warne and Co, Ltd, 1959) 30*s* net

THIS book, the first published since 1892 to key all the British species of Hemiptera-Heteroptera, should be valuable both to the person who wishes to recognize and learn something about the occasional bug that crosses his path and to the student of the group The former will find the generally accurate coloured plates and black-and-white drawings will help him to recognize many of the species, while most of the keys are practical and not difficult to use Perhaps one exception is the key to the subfamilies of the Miridae (here the authors have my sympathy), which might be accompanied by a warning that the arolia and pseudo-arolia are not readily visible on carded specimens, also the term 'collar' is not accurately defined Some of the keys, too, might have more references, including pagination, to the text figures The keys and illustrations are usually sufficient for easy recognition the book gives no further description of the adult insect

Technical terms are generally used but are very well defined in the glossary Another useful feature is a list of plants in alphabetical order with references to the bugs usually associated with each There are also practical notes on collection, preservation and study

The specialist will find this book a valuable and up-to-date compilation of details of the biology and distribution of the species, amply substantiated by numerous references. The diploid chromosome complement is given, when known Confusion may sometimes be caused by the complete absence of synonyms in this book, a few of the new names being unfamiliar to many collectors

W. J. LE QUESNE

British Parasitic Fungi

A Host-Parasite Index and a Guide to British Literature on the Fungus Diseases of Cultivated Plants By W. C Moore Pp xvi+430 (Cambridge: At the University Press, 1959) 45*s* net

WHEREVER crops are grown the study and control of fungus diseases is of major importance This is reflected in the vast and scattered literature relating to diseases of economic plants Every time the plant pathologist finds a disease which is new to him he is faced with a time-consuming search through this literature, much of which may not be readily accessible This task will be greatly lightened for the British plant pathologist by the publication of Mr Moore's book The book is in two sections the first giving lists of recorded parasitic fungi, together with some actinomycetes, for every plant of any economic importance grown in Britain The second section lists the parasites alphabetically and for each gives the correct name and original reference, well-known synonyms and the common name(s) of the disease(s) caused For the more important diseases useful data relating to incidence and history and a list of the more important papers dealing with the various aspects of the disease are also given

Mr. Moore brings to the compilation of this book an unrivalled knowledge and practical experience of diseases of economic plants in Britain, and the book will be an indispensable and authoritative work of reference for all mycologists and plant pathologists. It is well arranged and clearly printed, so that any desired item can be turned up at once It will assuredly save many hours in the identification of plant diseases and the tracking down of the relevant literature

LILIAN E HAWKER

Rivers and Man

By Dr. Robert Brittain Pp 288+13 plates. (London and New York Longmans, Green and Co, Ltd, 1959) 21*s* net

THE changing relationship between rivers and men through time is a fascinating topic and well worthy of the attention of the wide audience aimed at by this book The writing is, to say the least, enthusiastic. The canvas used is a broad one and the picture has been executed in glaring colours The technically qualified will cringe many times as over-generalization follows over-generalization The book as a whole raises the perpetual problem as to how science may be popularized without sacrificing the truth The first chapter on the making of the world consists of a large number of undigested snippets of geological fact and fiction In dealing with archæological matters in the remaining ten chapters the author is more, in fact, much too plausible and uncritical. The impression gained is that archæology has no problems, that no one was ever in any doubt as to the meaning of evidence. Is this the kind of image of itself that science wishes to project? I think not

E H BROWN

Détecteurs de Particules (Compteurs et Scintillateurs)

Mécanisme et Réalisation Par Daniel Blanc Pp v+324 (Paris Masson et Cie, 1959) 3,900 francs

THE progress of experimental nuclear physics has been very dependent on the development of new experimental apparatus at the appropriate time In the case of detectors for nuclear particles, the new device is frequently in common use in the research laboratory long before the detailed mechanism of the detector is fully understood The book under review was intended to collect together for the French-speaking physicist our present knowledge of detectors Its completeness, therefore, makes it rather useful Although more complete treatises on particular detector types exist in English, no recent one includes all types as this book does Moreover, a useful balance is struck by M Blanc between the theories of detection mechanisms and the recipes for making workable devices

Rather more than half the book is devoted to ion-chambers, including a fairly complete discussion of the Geiger–Muller counter Most of the remainder is devoted to scintillation counters of all kinds, including a useful discussion of photo-multiplier types Chapters on spark counters and crystal counters are also included Unfortunately, the latter does not include semiconductor-junction counters Over the past year these have proved to be an exciting new development of the greatest importance Aside from this omission references are given very fully up to June 1958 The greater part of this volume should not go out of date too fast and will prove to be an invaluable handbook especially for the graduate student in nuclear physics

E B PAUL

IONIC PARTITION AND FINE STRUCTURE IN MUSCLE

By Dr. SHIRLEY E SIMON

Department of Pharmacology, University of Melbourne

THE necessity for reconciling the highly developed structural organization of muscle with existing concepts of ionic accumulation, and the nature of the bioelectric potential, has been stressed in several recent papers[1–4] The idea of the cell as a simple osmometer, in which a moderately distensible membrane separates two more or less equally randomized aqueous phases, would seem inadequate in the light of our knowledge of the detailed morphology of the system[5,6] It is well recognized[7] that there is a gap between our knowledge of the ultra-structure of the system and the physiological function, and it would seem that an attempt to integrate the information obtainable from divergent fields of study should be fruitful

A notable advance of this nature has been made by Porter and Pallade[6], who have suggested that the sarcoplasmic reticulum may be concerned in the intracellular transmission of the action potential, and thus provide the morphological link between conduction and contraction This hypothesis was based on their own observations of the fine structure of the reticulum, and on the work of Huxley and Taylor[5,8,9] These latter authors were able to demonstrate that the local depolarization of the membrane by means of a micro-pipette led to contraction of the adjacent myofibril only if the pipette was placed opposite the *I*-band

A full discussion of the function of the 'endo-membranes' of the cell has been given by Ruska *et al* [2], both from the point of view of the intracellular transmission of the membrane potential, and as phase boundaries which separate the various compartments of the cell These authors also list the relevant bibliography

Ruska *et al* have been concerned chiefly with the electrical inhomogeneities of the system They have inferred an ionic inhomogeneity chiefly from the electrical evidence It would seem, however, that evidence for intense ionic gradients within the cell can be deduced from other observations, and can therefore be considered to support the electrical findings.

The Three-phase Theory

Work carried out in this laboratory has led to the formulation of a three-phase theory to account for the ionic discrimination shown by muscle The evidence for this theory has been detailed in several publications[3,4,10], and it will suffice here to note the main points whereby this model differs from the classical concept of a membrane-mediated discrimination The three phases postulated are the extracellular phase, the free intracellular phase and the ordered phase It is assumed that those ions which are accumulated by the cell are adsorbed by the ultra-structure of the ordered phase, which is envisaged as a highly ordered macromolecular gel extending throughout the greater part of the cell Other ions of the external medium will be excluded from this region of the cell and will be confined to the free intracellular phase This exclusion of certain ions from the greater part of the cell will result in an apparent concentration gradient for these ions across the cell membrane It has been a prime thesis that these 'free intracellular phase' ions should be in a diffusion equilibrium with the external environment, that is, the maintenance of the apparent concentration gradient across the cell membrane results from their partial or complete exclusion from the ordered phase, rather than from the active extrusion of the ions by a pump mechanism It is clear that such a system obviates the necessity for the continuous feeding in of metabolically derived energy in order to maintain the cell in the resting condition

Evidence for the Three-phase Theory

We have studied the partition of a large number of ions across the membrane, and find that they may be roughly divided into two groups those which are accumulated in the ordered phase, and those which are at least partially excluded from it The accumulated ions are potassium, magnesium, calcium and inorganic phosphate Rubidium and cæsium may to some extent substitute for potassium Sodium and chloride are considered to be largely excluded Lithium has been found to behave similarly to sodium , and bromide, iodide and sulphate ions may be regarded as chloride substitutes

The distribution of these ions has been studied both at the steady state and with kinetic methods The results obtained at the steady state have enabled an estimate to be made of the amount of muscle water available in the ion in question, and have also shown the effect of the ion on the normal ionic constituents of the cell The kinetic experiments have enabled us to estimate the rate of movement of the ions into and out of the cell and to determine the effect of changes in environment on these rates[4,10]

The information obtained at the steady state indicates that, as a first approximation, the same amount of muscle water is available to chloride, iodide, bromide and sulphate ion[4,10] The value found for the lithium space is less than for sodium after soaking for 4 hr , and resembles the anion space It was found, however[4], that the lithium space tended to increase with increased time of soaking in the lithium Ringer solution, until at 18 hr it equalled and occasionally exceeded the sodium space This was cited as provisional evidence for the binding of part of the cellular sodium Some type of competition between sodium and lithium for the binding site was envisaged

We have shown previously[3] that when a muscle is equilibrated in normal Ringer solution and then transferred to a solution in which half the sodium chloride is replaced with sucrose, there is a net movement of sodium chloride out of the cell against the concentration gradient. This net movement of sodium chloride is not accompanied by any movement of potassium, nor is it dependent upon the presence of potassium in the external medium. These experiments were repeated with Ringer solution in which all the chloride was substituted with iodide or bromide, and an analogous outward movement of these ions was demonstrated. When, however, this experiment was repeated with lithium, we were unable to show a significant decrease in intracellular lithium when the muscles were transferred to a lower level of external lithium. This and kinetic evidence (Fig. 1) led us to believe that lithium is bound in the cell in a similar fashion, but to a greater extent, than sodium. The failure of lithium to leave the cell in this experiment would then result from the shape of the adsorption isotherm.

It is considered that this adsorption takes place in the free intracellular phase[4], and we must therefore revise our original postulate that ions in this phase are in a diffusion equilibrium with the external medium. This would appear to be true for the anions we have studied, but it would seem that there is some cation-binding in this phase.

The discussion has so far been restricted to the partition of 'excluded' ions between the cell and the external medium. If it is assumed that ions which are accumulated in the ordered phase are in such a condition that the adsorption sites approach saturation, then increases in the external level of the ion in question should result only in increases in the level of the free phase of the ion. Consequently, the ratio of external level to increase in internal level should approximate the ratio out/in for an excluded ion. It may be seen from Table 1 that such an approximation does hold true.

Table 1. COMPARISON OF THE RATIO OF EXTERNAL CONCENTRATION TO INTERNAL CONCENTRATION FOR VARIOUS IONS

Excluded Ions		Accumulated Ions	
	Ratio out/in		Ration out/increase in internal level
Sodium	4.5	Calcium	2.3
Lithium	6.7	Magnesium	6.7
Chloride	5.4	Phosphate	3.6
Iodide	7.4		
Sulphate	7.1		

Each figure is the mean of 12–40 observations. The muscles used were the sartorius muscle of the toad *Bufo marinus*, which were immersed in the appropriate solution for 4 hr.

Definition of Phases

The extracellular phase has been defined as that amount of the muscle water which is available for the free diffusion of inulin or albumin labelled with iodide-131 (ref. 11), and is presumed to coincide morphologically with the region outside the cell membrane.

The free intracellular phase has been defined as an intracellular region intermediate in order between the extracellular phase and the ordered phase. It may be regarded as an intracellular extension of the external phase, but we have never envisaged it as merely an annular region beneath the cell membrane[3,4]. It would seem probable that we can identify this phase with the sarcoplasmic reticulum[6]. This complex tridimensional lattice is a membrane system separating two distinct intracellular phases, which is continuous both with the plasma membrane and the peri-nuclear cysternæ. The electron microscope has revealed no fine structure within the tubules of the reticulum, but the limiting membrane seems to be

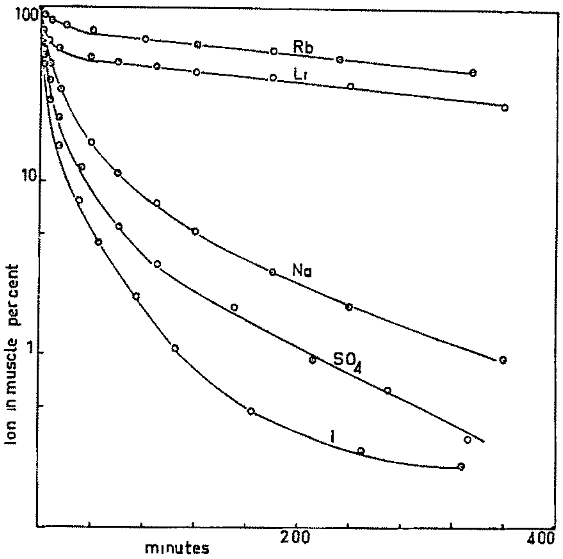

Fig. 1. Efflux of various ions from muscle. All muscles were loaded in the appropriate solutions for 18 hr., then effluxed into Ringer solution. The amount of the ion remaining in the muscle has been plotted as a percentage of that originally present. Lithium and rubidium were estimated photometrically. The effluxes of sodium, sulphate and iodide were followed with isotopes

similar in thickness to the plasma membrane. This phase appears to have a lower concentration of protein than the surrounding cytoplasm[2], and it is likely that this region is more randomized than the matrix.

The ordered phase is defined as that part of the cell which by virtue of its ordered macromolecular structure is able either to accumulate or exclude the ions of the external environment. This region is likely to be morphologically heterogeneous, and will include the contractile mechanism, mitochondria, nuclei, etc.

Intracellular Active Transport

From the point of view of the three-phase theory, it might be supposed that the limiting membrane of the sarcoplasmic reticulum could actively transport ions in the same way as has been postulated for the plasma membrane. Thus this membrane, which is presumed to be located at the boundary of the free and ordered phases, could constitute not only an inner barrier to diffusion but could also play a part in ionic discrimination. It has been suggested, in fact[12], that parts of the plasma membrane may migrate into the cell to participate in the formation of the endoplasmic reticulum, and the reticular membrane could therefore be expected to have permeability properties similar to those of the plasma membrane. It has been calculated that the surface ratio of plasma membrane to reticular membrane in muscle fibres is at least four times greater for the reticular membrane[2]. One must therefore suppose it to be highly impermeable to the ions bathing either face, or the work of active transport necessary to separate the ions would be enormous.

The most serious criticism that can be levelled at the active transport theory must remain that it places great demands on the energy-producing systems of the cell. If it could be shown that the energy required to transport the various ions exceeded that obtainable from resting metabolism, then this would constitute a definite refutation. There have been numerous attempts to compute the energy requirements of the sodium pump, and almost as many different estimates have been obtained[13].

To date, no author has succeeded in comparing with sufficient accuracy the rate of movement of the transported ion with the amount of substrate consumed at the same time[14,15]. A further difficulty resides in the fact that one may question the validity of the computations which have led to estimates of the rate of movement of the ions across the cell membranes.

Analysis of Kinetic Data

It has generally been assumed that the membrane constitutes the principal rate-limiting step to the efflux of labelled ions from the cell, and that movement through the cytoplasm may be regarded as fast compared with movement across the membrane. Thus the system is considered to be effectively stirred, and one would expect to obtain an efflux curve which could be divided into an intra- and extra-cellular portion on the basis of a double exponential loss. The postulate of a uniform intracellular ionic distribution would appear to be unjustified in most cells, and Wilde[16] has called for a more realistic approach. Shanes[17] has mentioned the possibility of sequestering of ions in the organelles, and Harris[18] has attempted to analyse his kinetic data as a function of diffusion through a cylinder with a resistive coating. One still, however, finds the belief[19] that the trans-membrane step can be expressed as a single exponential function.

Experiments which have been carried out in this laboratory have shown that the movement of various ions out of the cell may yield efflux curves of widely differing form (Fig. 1). It would seem unlikely that these vastly differing curves could arise from a similar mechanism of transport across the membrane. It may be noted that lithium and rubidium show similarly shaped effluxes. Since lithium is considered an 'excluded' ion, and rubidium is an 'accumulated' ion, the effluxes cannot be divided into two groups, on the basis of whether their exit or entry is the active or energy-requiring movement.

In all these effluxes we have been concerned with estimating that proportion of the efflux which is due to extracellular material, and what may be considered to be unequivocally intracellular. The only curves in Fig. 1 which approximate to the double exponential loss expected from the membrane theory are the lithium and rubidium effluxes. Since these ions can be followed in their movement out of the cell photometrically, it was possible to estimate the extracellular space with albumin labelled with iodide-131 in the same muscle[11]. The amount of lithium or rubidium in the fast fraction of the efflux was determined by the straight-line extrapolation of the slow fraction back to the concentration axis, and the subtraction of this quantity from the total. The 'apparent' extracellular space for the ion was calculated by dividing this quantity by the external concentration of the ion, and this space was compared with the albumin space in the same muscle. The extracellular space calculated from the efflux curve exceeded in every instance the albumin space. The fast fraction of the lithium efflux gave an apparent extracellular space which was approximately 50 per cent greater than the albumin space, but there was no correlation between the two quantities. The amount of rubidium in the fast fraction of the efflux was also too great to be considered purely extracellular. The apparent extracellular space for rubidium calculated from the efflux observations could be linearly related to the total rubidium-level of the muscle, and the correlation was significant at the 0·1 per cent level.

From information such as this, it has been postulated that there is a fast- and a slow-moving intracellular fraction of these ions, and consequently the main rate-limiting step cannot be considered to be operative at the membrane. In the case of rubidium, it would seem likely that there is an equilibrium between the amount of material in the two intracellular fractions.

The efflux curves obtained with iodide and sulphate ions differ from the rubidium and lithium curves in that there is no well-defined rate-limiting step, and the efflux must be considered to be governed by diffusion rather than a membrane. The amount of intracellular material in these effluxes was determined by following the loss of the tracer from the muscle until the amount remaining approached background, and then transferring the tissue to albumin labelled with iodide-131. It was found in each instance that approximately one-third of the activity lost from the muscle as inorganic iodide-131 or sulphate-35 was intracellular in origin. Inspection of Fig. 1 will show that the movement of these ions across the membrane must consequently be very fast. Harris[20] has also noted that chloride crosses the membrane with great facility.

The efflux of sodium from the cell can be described as being composed of three major exponential terms. It would appear essential that the efflux be followed for long enough for these terms to be fully revealed. It will be obvious from Fig. 1 that effluxes which are terminated after 40–120 min. may be described as the sum of two exponentials, which cannot be related with likelihood of success to any cellular compartment. Further, failure to take into account the later fraction will alter the rate constants of the early components[4].

An attempt was made to establish which (if any) of the three exponential terms of the sodium efflux could be equated with extracellular material. This was done by comparing the amount of material in the various components with the extracellular space as determined with inulin in the companion muscle[11]. It would seem that, as a first approximation, the fastest of the three terms could be due to extracellularly derived material. Thus, amphibian muscle must be considered to contain a fast- and a slow-moving intracellular fraction of sodium, as well as of rubidium and lithium.

It follows from this discussion that (*a*) movement of ions across the membrane appears to be more rapid than was previously thought likely; (*b*) since the principal rate-limiting step is not operative at the membrane there may be considerable difficulty in determining the time constant of the energy-requiring step. Thus on our present information attempts to equate the energy-requirements of active transport with the resting metabolism would seem to be hazardous.

Kinetic Evidence for Intracellular Compartments

In any discussion of the structural organization of the living cell, one must bear in mind the extreme lability of the system being studied. It is well recognized that all histological procedures will give a static picture of a dynamic situation, even allowing for the minimum amount of distortion in the preparative procedures It is perhaps not so obvious that kinetic studies may be equally misleading It is a simple matter to obtain the rate constants of the various components for any efflux curve which may reasonably be described as the sum of two or three exponentials One becomes less confident when attempting to identify the amounts of material in any component with the morphological compartments of the cell As was mentioned above, this type of analysis assumes that the material in the various compartments is effectively stirred, or that movement through the compartment is fast compared with the rate of transfer across the limiting membrane

Berman and Schoenfeld[21] have discussed the validity of the 'compartmental approach', and stress that a compartment must be considered an average rather than an exact state Any experimental system must be considered as a closed box , we do not know what is in the box , but it must preserve a certain input–output relation for the type of experiment performed If this relation is such that it can be analysed mathematically as the sum of n distinct compartments, then it can be defined as such , but this definition need not correspond to the true configuration of the system

Thus, with available techniques, much of our discussion of the localization of intracellular functions must be speculative Information derived from kinetic studies alone will not suffice for us to decide whether intracellular sodium is indeed located in the sarcoplasmic reticulum

Physico-Chemical Considerations

The postulate of a three-compartment system for muscle has been based on evidence derived from a study of the distribution of a number of inorganic ions between the external medium and the cell. No attempt has been made to describe the mechanism whereby the ordered phase can accumulate or exclude the various ionic species It is possible that our knowledge of complex ion–protein systems is still too tentative to permit of an understanding of the process of ionic discrimination There are, however, certain physico-chemical considerations which must apply at the cellular level, whether we are concerned with the membrane-based discrimination or a cytoplasmic discrimination

Ling[22] has made an attempt to relate ionic differentiation to fundamental concepts, and has been criticized because his theories appear incomplete Conway[13] has referred to the theoretical fallacy in Ling's central idea, which in his opinion lies in Ling's assumption that the hydrated potassium, because of its smaller size, can enter farther than the hydrated sodium into a zone of reduced dielectric constant around the fixed anionic site It would appear that both these authors have used an over-simplified approach to the problem of cation – macromolecular interactions, and in particular it should be pointed out that the degree of hydration of a cation varies with the dielectric constant of the medium The fixation of cations on the ionized groups of water-soluble macromolecules has been discussed in a comprehensive treatise by Bungenberg de Jong[23] The relative affinity of any cation and the fixed anionic site must depend upon the valency, radius and polarizing power of the cation, and on the polarizability of the negatively charged group of the colloid Since the phenomenon of cation fixation occurs in an aqueous medium, the polarizability of the water itself must play a part Whether the polarizability of the fixed group is more or less than water is of great importance in determining the affinity of the cation for the site The characteristically opposite behaviour of phosphate and sulphate colloids in cation fixation can be explained from the different polarizabilities of the ionized groups, phosphate being more strongly polarizable and sulphate less polarizable than water This will result in an affinity order for cation fixation by sulphate colloids of potassium > sodium > lithium, whereas in phosphate colloids this order will be reversed lithium > sodium > potassium

In this respect it is of interest to note that Kirschner[24] has demonstrated sodium-binding by phospholipides from pig erythrocytes

At least one of the complicating factors in transferring this type of colloid chemistry to living systems would be that the polarizability of the fixed anionic groups would be altered by adjacent polar groups in the macromolecule, which could be expected to undergo change at different times in the metabolic cycle

Ultra-structure studies have indicated the presence in the cell of an ordered array of macromolecules[25] It would seem that a necessary concomitant of such a definite molecular pattern must be that the cell contains a differential distribution of inorganic ions

In considering the nature of the interaction between sodium and potassium and the binding site, whether the site be considered cytoplasmic or a membrane carrier, most authors have considered the hydrated radius to be the operative dimension[22,26,27] An exception is provided by Solomon[28], who was able to relate his results for the movement of monovalent cations into the red blood cell better with the naked than with the hydrated radius

However, the degree of hydration of the cation is merely a reflexion of its polarizing characteristics If the ion finds itself in the vicinity of a group which is considerably more polarizable than water, for example, the phosphate group of lecithin, it will shed its water of hydration because a much larger polarization energy is set free on the attachment of the anhydrous ion to the phosphate group From considerations such as these, Bungenberg de Jong[23] has suggested that all variants of the type colloid anion + micro-cation involve this very close approach between the charged groups However, these direct contacts are not to be thought of as static, and therefore permanent They will be dynamic and of short duration, so that over a period of time the contact will be broken, and fresh contacts made

It is clear from this discussion that even in the absence of the biological turnover of a binding site due to metabolic breakdown and re-synthesis, one could expect a considerable exchange between (say) bound potassium and potassium-42 added to the external environment

Complex Coacervation in Biological Systems

A phase separation may occur when two oppositely charged polymers are mixed together The resulting system has been termed a coacervate, from the Latin *acervus*, a heap The two-phase system will consist of one phase which contains the greater amount of the two polymers, and another which contains a small amount of one or both of the polymers, and a large amount of the dispersion medium If the system also contains an appreciable amount of micro-ions, these will be distributed between the two phases in a manner characteristic for the system under consideration

Overbeek and Voorn[29] have emphasized the importance of this type of concept in our approach to the physical chemistry of cytoplasm, and Troshin[30] has based his theory of ionic discrimination on this type of consideration The coacervates as described by the Dutch workers behave as regards their viscosity like Newtonian liquids Thus, the association of macromolecules in the coacervate may be regarded as dynamic, there being both intra- and intermolecular points of contact of the statistically kinked macromolecules

One should differentiate sharply between the type of coacervate obtained by the association of a linear polymer, and the colloid-rich phase which may be obtained with corpuscular proteins When this latter type of protein is obtained in the low-dispersed form, one usually obtained colloid crystals, rather than liquid coacervates The colloid crystals will owe their stability to the presence of lateral bonds between groups of contiguous folds of the macromolecule, or between sub-units, which will counteract the tendency of the macromolecule to form the most probable shape, that of the statistically kinked macromolecule

Such a description would seem to fit in very well with the physical chemistry of such high molecular weight compounds as the deoxyribonucleic acids[31] It may be suggested that the ordered phase (or at least the organelles) conforms to this type of macromolecular pattern more than to the random liquid system of complex coacervation

The ability of the ordered phase to exclude an ion by some mechanism other than membrane impermeability may be questioned It would seem improbable that cytoplasm, which consists of 80 per cent water, would contain a sufficiently large amount of water in the 'bound' state to explain the exclusion of sodium If, however, the cell is considered as a system of modified complex coacervates, then the partition of salts between the two partially immiscible phases would be entirely different from that obtaining in the test-tube The ordered phase, therefore, will be a colloid-rich phase in which there is a high degree of molecular orientation and structural differentiation The free intracellular phase, which we tentatively identify with the sarcoplasmic reticulum, will conform more to the labile, short-term pattern which is typical of coacervates

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SCIENTISTS AND ENGINEERS IN BRITAIN[*]

THE second report on scientific and engineering man-power from the Committee on Scientific Man-power of the Advisory Council on Scientific Policy compares the situation in Great Britain in 1959 with that in 1956 and estimates the developments likely by 1962 Like the first report, it is based on information collected by the Ministry of Labour and National Service, this time in the first three months of 1959, covering private industry, the nationalized industries and public corporations, central and local government (excluding education and the Armed Forces) and education, but agriculture is again excluded as well as self-employed persons, persons employed by firms of consultants, and scientists and engineers working outside Great Britain The inquiry is slightly more comprehensive than that in 1956, which excluded firms employing less than 100 workers, for it covers, besides all establishments employing 500 workers or more, a sample of those with 11–499 workers (31–499 workers in the building and contracting industry) It is estimated that the employments covered account for nearly 90 per cent of all qualified scientists and engineers in Great Britain As in the previous report, these terms are applied to persons with one of the following qualifications a university degree in science or engineering , the diploma in technology , an associateship of one of the higher educational institutions , graduate or corporate membership of one of the professional institutions Technologists with specialist qualifications in branches of applied science such as textiles, rubber and plastics are again excluded, unless they qualify as defined above

For early 1959 the report gives the total of qualified scientists as 63,200 and of engineers as 89,200 , 43,600 of the grand total possessed the higher national certificate or diploma of technology only Of the scientists, 21,200 are employed in manufacturing industry, 1,000 in industrial research associations, 3,200 in nationalized industries, 6,400 in central government and 28,700 in education , 2,000 are employed in other manufacturing industry and 400 others in teaching. For engineers the corresponding figures are 42,400, 600, 17,000, 8,500, 3,300, 4,900, and 1,300, 4,100 qualified engineers are employed in the building and contracting industry and 6,600 by local authorities. It is estimated that 5,000 scientists and 9,600 engineers are in employment not covered by the inquiry, and 4,000 and 2,000 respectively in postgraduate research. The grand total of 173,000 represents an increase of 19·3 per cent over the 1956 figures and an increase from 6 to 7 in the number of scientists and engineers per thousand of the working population, apart from the 43,000 possessing no higher qualification than a higher national diploma or certificate.

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[*] Scientific and Engineering Manpower in Great Britain 1959 Pp vi+48 (Cmnd 902)(London H M Stationery Office, 1959)3s net

Of this increase, 62 per cent has gone into private manufacturing industry, 13 per cent to nationalized industry, 17 per cent to education, and 8 per cent to central and local government, more than half the increase in the nationalized industries and public corporations being attributable to the Atomic Energy Authority, where the increase was 71 per cent (2,470 to 4,220), and a further increase of 42 per cent by 1962 is anticipated. Taking scientists and engineers separately, manufacturing industry has gained 53 per cent of the scientists and 69 per cent of the engineers, for nationalized industry the figures are 8 per cent and 16 per cent, respectively, for central and local government, 6 per cent and 3 per cent; and for education, 32 per cent and 6 per cent, respectively. The actual increase of 19·7 per cent or 23,600 compares with the employers' forecast of 32,500 or 27·2 per cent, for manufacturing industry the actual increase was 30·2 per cent, for research associations, 10 per cent, for nationalized industry, 18·4 per cent, for central government, 7·5 per cent, local government, 3·8 per cent, and education, 14 per cent.

Nearly 70 per cent of the net gain for manufacturing industry in scientists and engineers is concentrated in electrical engineering, chemicals and allied trades, other plant and machinery and aircraft. As regards private manufacturing industry as a whole, the proportion of qualified scientists and engineers to the total number of persons employed rose from 8 to 11 per thousand. In most industries the percentage engaged on research and development showed little change compared with 1956. In the shipbuilding, ship-repairing and marine engineering group it increased from 9 to 20 per cent, and in the railway equipment industry from 5 to 23 per cent, but in the aircraft industry there was a substantial increase in the proportion of scientists and engineers engaged on work other than research and development. In manufacturing industry as a whole, 41·2 per cent of scientists and engineers were engaged on research and development compared with 44·5 per cent in 1956, in electronics the figure was 66 per cent, for precision instruments, 60 per cent, for aircraft, 54 per cent, for heavy electrical engineering, 53 per cent, and man-made fibres, 51 per cent. Establishments with staffs of 500 or more employed 69 per cent of the scientists and engineers in this sector, but only 46 per cent of all persons engaged in manufacturing industry, for scientists the figure is 64 per cent, and for engineers 71 per cent, and 68 per cent of these scientists and 80 per cent of the engineers were engaged on research and development. For establishments employing more than 100 workers a proportionately smaller increase in the number of engineers and scientists employed was expected during the next three years compared with 1956–59.

The industrial research associations which in 1956 employed nearly 1,400 scientists and engineers hope to employ 1,800 by 1962—an increase of 17 per cent in the next three years, whereas the nationalized industries hope to employ 24,900, an increase of 20 per cent on the 20,700 employed in 1959, and of 18 per cent on 1956. For the Gas Council and the Area Gas Boards, the increase was 17 per cent, for the National Coal Board, 15 per cent, and for the Electricity Authorities, 2·5 per cent; but the latter employed an appreciably higher proportion of qualified scientists and engineers (30 per thousand) than the average for manufacturing industry or for the other public corporations except the Atomic Energy Authority (123 per thousand). Whereas for all other public corporations only 8 per cent of scientists and engineers on average were employed on research and development, for the Atomic Energy Authority the figure was 63 per cent, and for the Airways Corporation 33 per cent. By 1962 the Electricity Authorities look for a further increase of 35 per cent in the number of scientists and engineers, and the British Transport Commission for a 29 per cent increase.

Whereas in 1956 the departments of central government expected to increase their total of scientists and engineers from 13,800 to 15,800 by 1959, the increase was only 7·5 per cent, mainly because the expected 11 per cent increase in the defence departments did not occur, the number employed remaining at 7,600. It is estimated that about 20,000 scientists and engineers, including those serving in the Armed Forces, were employed on defence work at the beginning of 1959, about half of whom were engaged on research and development, and accounting for about 25 per cent of all scientists and engineers engaged on research and development in industry and government research establishments compared with 40 per cent three years ago. The fall in the proportion in the aircraft industry engaged on research and the smallness of the increase in qualified personnel in the electrical engineering industry may be due to cuts in defence contracts.

The civil departments employ nearly 4,600 scientists and engineers, or about 30 per cent of the total employed by the central government. An increase from 2,350 to 2,700 in the number employed by the research councils between 1956 and 1959 reflects principally the planned expansion in the Department of Scientific and Industrial Research under the five-year plan initiated in 1954, and the 12 per cent increase forecast by the civil departments by 1963 includes a 16 per cent increase for the research departments, covering provision for the second five-year plan for the Department of Scientific and Industrial Research, which calls for a 6 per cent a year increase in its professionally qualified staff. In the same period, the defence departments anticipate a reduction in the total number of scientists and engineers to 7,450 as the net result of a 6 per cent increase in scientists and a 6 per cent decrease in engineers.

Of the 6,700 scientists and engineers employed by local authorities in 1956, about 80 per cent were civil and structural engineers. In 1959 the total was more than 6,950, but 1,150 immediate vacancies are reported and an increase of 25 per cent is hoped for by 1962. The increase among civil and structural engineers in 1959 was 11 per cent, but the number of mechanical engineers fell from 660 to 370.

The current scientific man-power position in education is discussed elsewhere (see p. 1971 of this issue), and apart from noting that some universities consider that their competitive position has improved in the past two years, it should suffice here to refer to the forecasts of requirements for teachers from 1959 until 1962 given in the report. For the universities an increase of 1,275, or 30 per cent, to 5,450 is forecast; for technical and teacher training colleges the corresponding figures are 1,620 (24 per cent) and 8,480; and for the schools 3,675 (16 per cent) and 26,290. The forecast of requirements for university teachers by 1962 assumes that two-thirds of the increased numbers of students reaching the universities by 1962 will read pure science or technology. It is also expected that by 1962 about 5,000 scientists and 2,500 engineers will be engaged on postgraduate work in the universities, compared with 4,000 and 2,000, respectively, in 1959.

The net increase in the forecast of requirements for technical colleges, teacher training colleges and schools includes about 1,000 current vacancies, nearly half of which are in Scotland, and it is admitted that the figure for England and Wales greatly underestimates the number of additional teachers needed to restore 1953 staffing standards. To reduce the size of swollen classes might require a further 4,000–5,000 science teachers.

The figures for various categories of scientists employed in 1959 (with the percentage increase on 1956 in brackets) are as follow: 6,400 biologists (25·5), 24,300 chemists (16·3), 800 geologists (−11·1), 13,000 mathematicians (12·1), 13,600 physicists (28·3) and 2,700 other scientists (28·6). For engineers the figures are: metallurgists, 3,600 (12·5); chemical engineers, 1,900 (26·7); civil engineers, 13,700 (7·0); electrical engineers, 20,000 (12·4); mining engineers, 4,600 (21·1); mechanical engineers, 34,000 (25·9); engineers in teaching, 3,300 (37·5). The following figures give the forecast of additional numbers required by 1962 (percentage increase on 1959 in brackets): biologists, 1,200 (17·6); chemists, 5,400 (20·5); geologists, 200 (25·0); mathematicians, 2,700 (19·6); physicists, 3,300 (20·2); other scientists, 200 (16·7); metallurgists, 1,300 (35·1); chemical engineers, 700 (35·0); civil and structural engineers, 3,300 (22·9); electrical engineers, 6,000 (27·9); mining engineers, 200 (4·3); mechanical and other engineers, 8,700 (23·8); engineers in teaching, 1,200 (26·1). The figures take no account of the demands abroad for scientists and engineers trained in Great Britain.

For 1962 a grand total of 87,100 scientists and 124,600 engineers is forecast by the inquiry, of whom 76,200 scientists and 110,800 engineers are required in fields covered by the inquiry and 5,000 scientists and 2,500 engineers in postgraduate research. Moreover, it is assumed that 6,000 scientists and 8,400 engineers will be needed to replace wastage from death, retirement, etc. Against this, an output of 51,650 scientists and engineers is forecast for the period 1959–62, of whom only about 47,500 will be available for employment in Great Britain compared with anticipated requirements of 53,100. About 60 per cent of the total will be university graduates (28,800), holders of the diploma in technology (900) or associates of one of Scotland's central institutions (750); the remaining 21,200 will be admitted to professional institutions on the evidence of other qualifications. By 1962 the annual output is expected to reach about 19,000 compared with 15,000 in 1958, and of the net 47,500 available for employment in Britain, 19,200 will be scientists and 28,300 engineers. Of the 5,674 scientists qualifying for the first time in 1958, 494 did so in biological sciences, 1,296 in chemistry, 167 in geology, 496 in mathematics, 755 in physics, 599 in general science, and 1,357 by pass degrees. Of the 9,326 engineers, 333 qualified in aeronautical, 325 in chemical, 1,047 in civil and structural, 1,658 in electrical, 734 in marine, 2,748 in mechanical, 504 in mining and metallurgy, 432 in production, 225 in municipal, 146 in naval architecture, and 1,087 in general engineering, etc.

NEWS and VIEWS

Australian Commonwealth Scientific and Industrial Research Organization Executive

THE appointment has been announced of two new members to the Executive of the Australian Commonwealth Scientific and Industrial Research Organization. This follows the passing last month of an amendment to the Science and Industry Research Act, enlarging the Organization's Executive. The new full-time members will be Mr. C. S. Christian, chief of the Organization's Division of Land Research and Regional Survey, and Prof. L. G. H. Huxley, Elder professor of physics in the University of Adelaide.

Mr. C. S. Christian

MR. CHRISTIAN has been associated with the Commonwealth Scientific and Industrial Research Organization ever since his graduation from Gatton College and the University of Queensland. In 1931 he studied genetics at the University of Minnesota, and in 1933 he held an appointment under Sir Ronald Fisher at Rothamsted Experimental Station. On his return to Australia, he undertook wheat and plant breeding research with the Commonwealth Scientific and Industrial Research Organization in Canberra and in Queensland. In 1946, following a request from the North Australian Development Committee, Mr. Christian organized the North Australia Regional Survey, which has since become the Commonwealth Scientific and Industrial Research Organization's Division of Land Research and Regional Survey. In 1955, Mr. Christian was invited by Unesco to advise in Syria on the establishment of a resources survey unit, and similarly in 1958 he went to India to plan a Central Arid Zone Research Unit. He is the Australian delegate to the International Rice Commission and president of Section K (Agriculture) of the Australian and New Zealand Association for the Advancement of Science. He has been president of the Queensland and A.C.T. branches of the Australian Institute of Agricultural Science.

Prof. L. G. H. Huxley

PROF. HUXLEY was educated at Hutchins School in Hobart, and at the University of Tasmania. He was the Tasmanian Rhodes Scholar in 1923, and went to New College, Oxford, in 1925, to read honours physics. He was awarded his doctorate in 1928, and returned to Australia in 1929, to carry out research for the Radio Research Board, under Sir John Madsen. He returned to England in 1931 and became in succession lecturer in physics at Nottingham, Leicester and Birmingham. During the War he was in charge of a radar school under the Ministry of Aircraft Production. Prof. Huxley returned to Australia ten years ago to take the chair of physics at the University of Adelaide. He is a member of the Councils of the Australian National University and the University of Adelaide. He has been associated with the Commonwealth Scientific and Industrial Research Organization through his chairmanship of the National Standards Commission and the Radio Research Board. He was a Foundation Fellow of the Australian Academy of Science, and is now the Academy's secretary (physical sciences). He is keenly interested in educational matters, being chairman of his University's Education Committee, and patron of the Science Teachers Association of South Australia.

Mr. G. B. Gresford

Two changes are also announced in the top administration of the Commonwealth Scientific and Industrial Research Organization. Mr. Guy B. Gresford has been appointed secretary and Mr. Walter Ives, executive officer. Mr. Gresford was educated at Trinity College, University of Melbourne. He joined the Organization in 1942. During the period 1943–46 he was in England on the staff of the Australian Scientific Liaison Office in London. He became assistant secretary of the Commonwealth Scientific and Industrial Research Organization in 1946 and research secretary (physical sciences) in 1952. In 1957, Mr. Gresford went to the United States on a Commonwealth Fund Fellowship, studying at the Harvard School of Public Administration and at the National Science Foundation in Washington.

Mr. W. Ives

MR. IVES graduated in economics at the University of Sydney. During the War he was with the Department of War Organization of Industry, and transferred later to the Department of Postwar Reconstruction. He joined the Commonwealth Scientific and Industrial Research Organization in 1946 as technical secretary of the Division of Plant Industry. He became assistant secretary of the Organization in 1950 and research secretary (biological sciences) in 1952. During 1954–56 he was chief scientific liaison officer at the Australian Scientific Liaison Office in London.

British Antarctic Party

THE third party of scientists and technicians of the Falkland Islands Dependencies Survey left Southampton on December 18 for the Antarctic aboard the Danish polar-exploration vessel, M.V. *Kista Dan*. Sir Vivian Fuchs, director of the Survey, flies from London on January 4 and joins the *Kista Dan* at Montevideo, where the vessel will take aboard two aircraft. These will be assembled at the ice edge to help in re-opening the Survey's southernmost base on Stonington Island (closed in March this year because of difficult ice conditions). Sir Vivian will take personal charge of this and allied operations and expects to be in the Antarctic for the rest of the summer season. The aircraft that will be used by the Falkland Islands Dependencies Survey will also support British exploration teams travelling south of Marguerite Bay. They will be operated by a Royal Air Force team of five. The Falkland Islands Dependencies Survey has maintained bases on the coast of Graham Land and nearby islands for fifteen years. At the bases, between 80 and 90 scientists and technicians spend periods of up to two years carrying out a regular programme of surveys, research and meteorological work. In January this year the Survey took over the base at Halley Bay (Coats Land) set up by the Royal Society expedition of 1955 as part of Britain's contribution to the International Geophysical Year, following the British Government's decision that scientific work should be continued there. Every antarctic summer, between November and March, the sea ice clears sufficiently for specially-built vessels to make the difficult voyage to Britain's Antarctic bases with relief staff and supplies. M.V. *Kista Dan* has been chartered by the Falkland Islands Dependencies Survey this season to supplement the work of its own vessels, R.R.S.'s *John Biscoe* and *Shackleton*. The former is expected to take part in the re-opening of the base on Stonington Island after she has relieved the Halley Bay base.

Nigerian College of Arts, Science and Technology

MORE than £85,000 was made available for the Nigerian College of Arts Science and Technology among grants and loans approved in November under the Colonial Development and Welfare Acts. Four grants were approved for the building programme of the College—£22,500 for a library and £15,322 for a 30-man hostel at its Zaria branch, and £18,750 for a library and £28,584 for a hostel block and two link blocks to accommodate 54 students at Ibadan. This brings to £1,087,719 the total made available for the development of the College since the first grant was approved in 1950. The College was established by the Nigerian Government as an autonomous federal institution, with branches at Enugu, Ibadan and Zaria, to share with University College, Ibadan, the task of providing higher education in the territory. It trains students in arts and science subjects leading to the United Kingdom General Certificate of Education (Advanced Level) and provides full professional courses leading to the examinations of appropriate professional bodies in Britain or to college diplomas, and certificate and other courses. The College is fully residential and it is hoped that by 1962 it will accommodate up to 1,250 students in its three branches. Total enrolment in the 1958–59 academic year was 875 students.

New Research Laboratories of Messrs. John and E. Sturge

NEW laboratories for organic and biochemical research work have been opened at Wheeleys Road, Birmingham, by John and E. Sturge, Ltd., as part of a plan to centralize the company's research work. One of the main activities will be fundamental research on fermentation problems, particularly in connexion with the microbiological production of citric acid, involving a close study of the biochemical and chemical aspects of the life-cycle of *Aspergillus niger* and the undertaking of an extensive mutation programme. The laboratories include an instrument room maintained at 20° C., a special cold room for enzyme manipulation in which the temperature can be kept down to 0° C. indefinitely, and sterile air-conditioned rooms to facilitate the handling of micro-organisms. The existing physical chemistry research laboratories at Wheeleys Road have been modernized, and are now fully equipped for radiochemical and high-vacuum work and for ultra-violet spectroscopy. At the company's Lifford Chemical Works, Birmingham, the analytical laboratories are being extended to cope with the testing of increased production, and the development laboratories have been rehoused in larger premises and now include a section for technical service work on rubber, plastics, paper, paint and printing inks. The Yorkshire laboratories at the company's Selby works—formerly devoted to the organic and biochemical research work—are now being used to extend the facilities of the development, analytical and microbiological departments. Construction work will start shortly on a new pilot plant, together with an associated laboratory and administrative offices.

Structure and Age of the Stars

THE improvements in our knowledge of nuclear reactions and of the opacity of stellar material are leading to corresponding advances in our ideas of the structure and ages of the stars. Developments in high-speed computers are playing a major part in this work, as may be seen from two recently published papers. C. B. Haselgrove and F. Hoyle (*Mon. Not. Roy. Astro. Soc.*, 119, 112; 1959) have constructed new models for stars of population types I and II, the latter having one-twentieth of the metal abundance relative to hydrogen that is present in type I. The integrations refer to uniform stars before substantial evolution has taken place. The results show that for stars with central temperatures less than about $2 \cdot 1 \times 10^7$ °K. the proton–proton reaction dominates the energy production; for hotter stars the carbon–nitrogen cycle is dominant. This central temperature is reached in stars of roughly twice the solar mass. Stars which are more massive than this also possess convective cores. An evolutionary run was obtained for a star of solar mass, and the age of the Sun, determined by fitting the observed luminosity, is $5 \cdot 2 \times 10^9$ years, in excellent agreement with the geophysically determined age. It also appears likely that the separation at zero age of the main sequences of the different stellar populations does not exceed 0·1 mag. In a second paper (*Mon. Not. Roy. Astro. Soc.*, 119, 124; 1959) Hoyle re-computes evolutionary sequences for stars corresponding closely to the lower portions of the globular cluster and the *M* 67 cluster giant sequences, that is, for types II and I, respectively. He concludes that both these type of stars must be aged at least 9×10^9 years. If it is assumed that type II stars are older than type I stars, Hoyle shows that the age of the Galaxy must be at least 10^{10} years, and that the cluster cepheid variables cannot be brighter than absolute visual magnitude $+0 \cdot 6$, a result in agreement with recent evidence from other lines of investigation.

Great Indian Rhinoceros

THE Great Indian rhinoceros, *Rhinoceros unicornis*, is one of the mammals the names of which appear on the list of animals in danger of extermination, which is maintained by the Survival Service Commission of the International Union for the Conservation of Nature and Natural Resources. In 1958, about 800 of these rhinoceros were believed to exist, of which some 400 were known to be in India. About the same number were thought to live in Nepal, in the valley of the River Rapti. The number of this rhinoceros in India was fairly accurately known because of the interest of the Indian Government, the attention given to the species by the Indian Board for Wild Life, and especially to the work of E. P. Gee. There were about 350 rhinoceros in sanctuaries in Assam—notably 250 in the Kaziranga Wild Life Sanctuary—and fifty in Bengal. About the number of rhinoceros in Nepal no accurate figures were known. In September 1958 a message from Katmandu came to the International Union for the Conservation of Nature stating that only about thirty-five rhinoceros remained in Nepal; the rest had been killed by poachers. The Survival Service Commission of the Union arranged for Gee to visit Nepal to investigate the distribution and status of rhinoceros in Nepal and to suggest measures for its preservation. A survey by Gee shows that the rhinoceros has not reached the levels which the message from Nepal had described, but the general picture is of declining numbers in a shrinking habitat. Gee's report has been accepted by the Survival Service Commission and given to the Union for appropriate action to preserve the Great Indian rhinoceros (*Oryx*, 5, No. 2; August 1959).

University News: Manchester

DR. F. FAIRBROTHER, reader in inorganic chemistry and assistant director of the chemical laboratories in the Faculty of Science, has been granted the status of professor of inorganic chemistry.

Oxford

THE following grants are announced: from the Nuffield Foundation for two years a sum not exceeding £8,000, for the continuation of research being carried out by H. B. Parry at the Nuffield Institute for Medical Research, under the direction of G. S. Dawes; from the du Pont Company, U.S.A., a grant of 3,000 dollars for the year 1960–61, for the support of basic research in the field of theoretical chemistry in the Institute of Mathematics, under the direction of Prof. C. A. Coulson; and £3,000 spread over three years from B.P. Trading, Ltd., for the purpose of continuing a research fellowship in geochemistry, to be nominated by the professor of geology.

Announcements

DR. EDGAR ZWILLING, professor of biology at Brandeis University, Waltham, Mass., has been appointed to serve a three-year term on the Embryology and Development Training Committee, which is administered by the Division of General Medical Sciences of the National Institutes of Health, U.S. Public Health Service. Dr. Zwilling will review applications for training grants in the basic sciences related to embryology and development, and will also provide technical advice to the National Advisory Health Council of the National Institutes of Health and the Surgeon General of the Public Health Service on matters pertaining to the research training problems of the nation.

ERRATUM. We regret that in the article entitled "Occurrence and Quantitative Determination of 2-Dimethylaminoethanol in Animal Tissue Extracts" in *Nature* of August 15, p. 551, the 17th line from the bottom of the right column should read "migration value where 'cysteine' has " instead of " where 'glycine' has ".

HEATING AND VENTILATION

BRITISH OCCUPATIONAL HYGIENE SOCIETY CONFERENCE

THE eleventh conference of the British Occupational Hygiene Society was held at the Institution of Mechanical Engineers on November 5, the president, Mr W H Walton, occupying the chair Dr T Bedford opened the proceedings with a paper entitled 'Requirements for Satisfactory Heating and Ventilation", in which he discussed the suppression of body odour, the combating of airborne infection, the release of toxic materials in factories and the maintenance of comfort The definition of comfort zones is effected, to a first approximation, by the dry-bulb temperature of the air This, however, could be misleading if radiation, atmospheric humidity and air movement are sufficiently large These were taken account of by the speaker's "corrected effective temperature", though it had to be remembered that individual preference differed, and so, too, did the general attitudes in different seasons and countries To be pleasant as well as comfortable the surrounding atmosphere had to contribute an element of stimulation This was associated in the first place with air-movement, which, while perceptible, was insufficient to constitute a draught The upper desirable limit depended on temperature Very low or very high relative humidities were often objectionable, but the optimum was not sharply defined The method of supplying artificial heat was important in the avoidance of stuffiness Warm walls had been found satisfactory, while the lower part of the body should be warmer than the upper with a gradient of 2° F to 3° F over the height of a standing man Heated ceilings required cautious use, for this reason Experiments with heated floors suggested that discomfort began when the surface exceeded 77° F

The engineering approach to air conditioning was explained by Mr B G Lawrence, of the National College for Heating, Ventilating, Refrigeration and Fan Engineering His paper, which will be of the utmost value to consultants in heating and ventilation, explained in detail the basic methods of heating, cooling and humidifying air and drew comparisons from which it was possible to decide upon the system best suited to a particular application

Work in hot environments was dealt with by Dr A R Lind, of the Medical Research Council Unit, for Research in Climate and Working Efficiency In hot surroundings men rapidly experience discomfort and fatigue, their working capacity falls, errors of perception and judgment appear and, ultimately, serious physiological disturbances are followed by collapse The heat exchange between the body and its surroundings is complicated by a rise in body temperature during work which becomes greater in climates that are too hot An appraisal of the heat stress imposed by given surroundings necessitates an understanding of the way in which the heat exchange will be influenced by the thermoregulatory system of the human body In the absence of such regulation a man hard at work would increase in temperature by 14 4° F an hour In hot surroundings, acclimatization after about two weeks plays an important part in enabling regulation to be extended beyond the normal limit, it is associated with improved circulation, which helps the transfer of heat from deep tissues to the surface of the skin Dr Lind compared various indexes of heat stress and concluded that the predictive value of the sweat-rate system was valid under the widest range of conditions It was of practical value to be able to use an index to define the upper limit of a tolerable thermal environment Work was at present in hand, for example, to determine the safe duration of exposure for personnel engaged in mine-rescue operations Permissible limits for everyday work were important in industrial, mining and Service activities, a comparison of naval and mining proposals was made The final section of the paper dealt with measures which could be taken to relieve heat stress and the probable physiological response to them

Flight Lieut J Billingham (Institute of Aviation Medicine) and Mr D J Day (Royal Aircraft Establishment) discussed cabin air-conditioning in military aircraft, the former covering physiological aspects and the latter engineering The problem of keeping the pilot comfortable presented novel features The air-cooling system had to extract a considerable amount of heat so that the difference in temperature between inlet and exit air might be as high as 50° F, even with a very high rate of air change The difference between wall and air temperature might also be large and in either direction Heat was produced by electronic equipment, but the exposed cabin walls were cold, on the other hand, the development of supersonic aircraft would result in heating of the cabin skin, and solar radiation had the same effect on its upper parts The humidity of air taken in to ventilate high-flying aircraft was practically zero Water could be added in civil machines, but the need to save weight might not permit this in military craft The clothing of air-crews varied a great deal Impermeable pressure suits might suffer from condensation of body moisture upon the inner surfaces and, for this reason alone, all such suits should be ventilated The pilot had to be able to control the air temperature to some extent, depending on his mean radiant temperature and his clothes The degree of variation, and of comfort provided, was a matter of balance between his deterioration in mental performance and the increase in the performance of the aircraft resulting from saving of weight A more severe stress could be imposed on a man embarking on a short sortie than would be tolerated during a long expedition

Mr Day directed attention to the properties of the I C A N standard atmosphere, which was the raw material for calculations on air supplies Real conditions often departed from this ideal specification In aircraft powered by gas turbines, a bleed from the compressor pressurized the cabin This air required to be cooled, its volume was decided by the heat load and the leakage rate Enemy action had to be considered in military planes and an excess of 4 lb /in ^{2} was not exceeded Up to 9 lb /in ^{2} was acceptable in civil machines, giving a cabin altitude of 8,000 ft at a true height of 47,000 ft Under the skin of the cabin, thermal insulation was provided by up to 1 in of superfine fibreglass Uniformity of temperature was achieved by careful arrangement of the air inlets. About 15 lb./min. was a typical figure for the air supply to a single-seat cockpit. Primary air cooling was performed by an air-to-air ram-operated exchanger. The heat picked up could not be rejected into the air stream, so it had to be used up by evaporating water or by heating up the considerable amount of fuel carried, which might even be refrigerated before loading. The final cooling, before admission to the cabin, was obtained by expansion. Temperature control was by a mixing valve.

The conference was concluded with a paper by Surgeon Commander S. Miles, of the Royal Naval Physiological Laboratory, who said that the nuclear propulsion unit brought with it the possibility that a man might in future spend a full commission beneath the surface of the sea, not necessarily as part of a defence programme, since the cargo-carrying submersible vessel was now the subject of study. The problem to be faced was the confinement of a crew in complete isolation while they worked, played, ate and slept encompassed by the sea. During this time a high standard of health and morale had to be maintained. The cumulative effect of a discharge of toxic agent made the risks abnormal. Carbon monoxide, carbon dioxide, body odours, fumes from cooking, paint, machinery and batteries had to be dealt with. The provision of oxygen from storage cylinders or chemical sources was expensive in space and might be replaced by the electrolysis of sea water or the absorption of dissolved gas, following the plan adopted by fishes. Water was readily obtained by distillation, but food was a problem. Cyclic feeding had been mooted by space-ship planners. The screening of the reactors was efficient and the only source of radiation could be an escape of coolant, which was guarded against by continuous monitoring. Luminous watch and instrument dials were banned. As a voyage progressed there was a swing to classical music in the popular taste, while conversation tended to become deeper. Educational courses were popular and afforded compensation for the long immurement. Exercise remained a difficulty.

The papers presented at this conference and the discussion on them will be printed in Vol. 2, part 3, of the *Annals of Occupational Hygiene*.

C. N. DAVIES

SELECTIVE OXIDATION OF TETRAPYRROLE SIDE-CHAINS

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IN studies to determine the nature of the side-chains and their relative positions on the nucleus in the tetrapyrroles, porphyrin *a* (ref. 1) and chlorin a_2 (ref. 2), we have made considerable use of selective oxidation methods, some of which are new to this field while others have been further investigated. Since these methods have also been of value in preparing various model compounds they are of general application in this field and this communication summarizes our experience.

Because of evidence that porphyrin *a* and chlorin a_2 (ref. 3) are hydroxylated compounds a method was required which would oxidize the alcohol group to carbonyl and thus demonstrate whether it was conjugated to the ring, but which would not cleave the vinyl or extended vinyl side-chain, known to be present in these tetrapyrroles. Fischer[4] employed potassium dichromate in pyridine to achieve this type of oxidation, but this oxidant in our hands gave poor yields together with degradation products. When acetone or glacial acetic acid was used as solvent, products with oxyporphyrin type spectra rapidly formed. However, oxidation of both primary and secondary hydroxyl groups could be readily effected with the reagent developed by Jones *et al.*[5] for the oxidation of acetylenic carbinols, in which chromium trioxide/sulphuric acid is used in conjunction with acetone as solvent. Oxidation was too rapid to allow for the appearance, with the dihydroxy porphyrins, of compounds with a single oxidized hydroxyl group. The order of reactivity in the porphyrin series of compounds was $CH_2OH > -CHOHCH_3 >>> -CHO$. Thus mono- and di-hydroxymethyl, or hydroxyethyl, deuteroporphyrins were converted to the corresponding formyl or acetyl porphyrins in high yield. 2-formyl 4-hydroxyethyl could be oxidized to 2-formyl 4-acetyl-deuteroporphyrin, little of the carboxy compound being formed. Where oxidation of the formyl group was preferentially required, the hydroxyl groups could be protected by acetylation. In this way 2-formyl 4-hydroxyethyl-deuteroporphyrin was converted to 2-carboxy 4-hydroxyethyl-deuteroporphyrin and 2-hydroxymethyl 4-formyl-deuteroporphyrin to 2-hydroxymethyl 4-carboxy-deuteroporphyrin. The formyl groups could be completely protected by formation of a Girard complex, but usually this device was not required.

In the dihydroporphyrin series (chlorins, rhodins) rhodin g_7 alcohol (derived from rhodin g_7 by reduction of the 3 formyl group with $NaBH_4$) was smoothly oxidized by this technique to the formyl compound, though care was required to avoid over-oxidation as the dihydroporphyrin ring tends to break down more readily than the porphyrin nucleus. The presence of side reactions was more marked in the case of the 2-α-hydroxyethyl compounds derived from phæophorbide *a*, pyrophæophorbide *a*, rhodochlorin and pyrochlorin[3], where a second compound with an oxyporphyrin type spectrum and a low Willstatter-hydrochloric acid number was obtained. The appearance of this type of degradation product on oxidation of the chlorin 2-hydroxyethyl compounds and its absence from the 3-hydroxymethyl compound are probably related to the significantly slower rate of oxidation of the secondary alcohol.

The procedure for oxidation was as follows. A few mgm. of the tetrapyrrole in 5 ml. of acetone, freshly distilled over potassium permanganate, cooled to 0° C., was treated under a nitrogen atmosphere with a very small drop of the chromium trioxide reagent which had previously been flushed with nitrogen. The drop was applied to the side of the test-tube and washed down by the acetone. The spectrum of the compound rapidly changed to that of the acid form and the formation of the oxidized product could be followed with a hand spectroscope.

On completion of oxidation—a matter of a few seconds—the acetone solution was poured into ether over 0·2 per cent sodium bicarbonate, and the ether then washed well with water. Any degradation product due to cleavage of the tetrapyrrole ring structure was washed out of the ether solution. When oxidation of the formyl group was required, the methyl ester was used since the carboxy porphyrin could afterwards be easily separated from non-acidic material by extraction with 1 per cent sodium carbonate.

Experiments were carried out using chromium trioxide dissolved in acetone for the oxidation of hæmatoporphyrin in the same solvent. With this system the porphyrin retained its neutral spectrum and the rate of oxidation of the hydroxyl group was much slower than with the Jones reagent, so that a mixture of the mono- and di-acetyl porphyrin was obtained. These products were readily separated by hydrochloric acid–ether fractionation and by alumina chromatography of the methyl esters.

Specific oxidation of a primary or secondary alcohol or of a formyl group was sometimes required. Manganese dioxide (prepared by the method of Attenburrow *et al.*[6]) in chloroform oxidized hydroxymethyl groups in the porphyrin series to formyl, hydroxyethyl groups remaining unaffected. Mono- and di-hydroxymethyl-deuteroporphyrin, 2-hydroxymethyl 4-vinyldeuteroporphyrin, 2-hydroxymethyl 4-hydroxyethyl-deuteroporphyrin and porphyrin *a* alcohol were in this way oxidized to formyl compounds, the vinyl and the secondary alcohol being unaffected. With the 2-hydroxymethyl compounds, 50 per cent oxidation took place within 1 hr., but in the case of compounds with the hydroxymethyl at the 4-position the complete oxidation required 12 hr. No detectable oxidation of the 3-hydroxymethyl group of rhodin g_7 alcohol was obtained with this reagent even after 72 hr.

Attempts to obtain specific oxidation of hæmatoporphyrin with aluminium-*iso*propoxide or butoxide, using acetone or *cyclo*hexanone, under reflux, did not give practical yields of the di-acetyl porphyrins, so that no specific method is available for the secondary alcohol.

Silver oxide has been used for oxidation of aldehydes[7] and Nicolaus[8] has prepared a pyrrolic acid with a carboxy side-chain, using silver oxide generated *in situ*. With formyl porphyrins we could not obtain more than a trace of the carboxy compound after prolonged treatment with either silver oxide previously prepared or precipitated *in situ* in alkaline media.

Lemberg and Parker[9] using potassium permanganate in acetone oxidized protoporphyrin to obtain chlorocruoroporphyrin and some diformyl and carboxy porphyrin, the relative proportions depending mainly on the concentration of the reactants. We thought it likely that oxidation beyond the chlorocruoroporphyrin stage might be reduced if the reaction was carried out at room temperature. The concentration of potassium permanganate (0·64 m.mole in 500 ml.) and of protoporphyrin (0·17 m.mole in 400 ml.) in acetone was the same as that found by Lemberg and Parker to give good yields of chlorocruoroporphyrin. To a solution of the porphyrin in acetone, potassium permanganate in the same solvent was added over a period of several minutes. A fine precipitate of manganese oxide formed after 10 min. or so, and oxidation was usually complete after 1 hr. The precipitate was spun off and the porphyrin taken into ether, and this washed thoroughly with water.

The addition of only a small amount of potassium permanganate resulted in the formation of formyl porphyrin from protoporphyrin, detectable by the appearance of a band at 556 mμ in the acetone solution. On further addition of potassium permanganate this band increased in density until it was much stronger than the 537 mμ of the remaining non-formyl porphyrin. But even when the potassium permanganate/protoporphyrin molar ratio was raised to 10 an absorption band was still visible at 537 mμ and this band was shown to be due to an oxyporphyrin (order of band intensity I, IV, III, II). At these higher concentrations of potassium permanganate some diformyl porphyrin was formed, but very little carboxy porphyrin. When chlorocruoroporphyrin or porphyrin *a* (porphyrins which have a vinyl group in the 4 position[10,11]) were treated similarly no oxidation of the respective vinyl groups was effected.

A similar resistance of the vinyl group in the compounds was found on hot oxidation with potassium permanganate, even when the concentration of the reactants was increased several-fold, although traces of the diformyl compound were obtained from chlorocruoroporphyrin, and from porphyrin *a* (Lemberg, unpublished work). But if the formyl group of chlorocruoroporphyrin or porphyrin *a* was reduced with borohydride prior to potassium permanganate treatment, then it was found that the vinyl group in these compounds was oxidized to a formyl, though less readily than with the 2 vinyl groups of protoporphyrin. Thus a new formyl porphyrin has been obtained from chlorocruoroporphyrin alcohol and porphyrin *a* alcohol respectively. That from the latter has absorption bands III and IV at 555 mμ and 514 mμ respectively (ratio III/IV = 1·3) in ether.

The hydroxyethyl groups of hæmatoporphyrin were completely resistant to oxidation with potassium permanganate in acetone by the method outlined above, even on refluxing for an hour. On cold oxidation monohydroxymethyl-deuteroporphyrin yielded about 1 per cent of formyl porphyrin, while refluxing for 1 hr. increased this to 5 per cent, so that vinyl groups in a hydroxylated porphyrin may be selectively oxidized by this method without the necessity of first protecting the hydroxyl groups by acetylation.

From these experiments it is evident that a formyl exerts an inhibitory effect on the rate of oxidation of a double bond conjugated to the nucleus, and secondly, that a vinyl group in the 2 position is much more reactive than one in the 4 position. From the evidence of the manganese oxide oxidation and other experiments carried out in this laboratory it is likely that other side-chains may exhibit this increased reactivity when situated in the 2 position of the tetrapyrrole nucleus. We propose to extend this investigation by examining the relative reactivities of substituents when present on different β positions of the tetrapyrrolic ring system.

Table 1

Substituted deuteroporphyrin	Absorption bands (mμ) I	II	III	IV	Spectral type (ref. 12)
Monoformyl monacetyl	646	587	561	521	Aetio
Monoformyl monohydroxyethyl	641	581	556	516	Rhodo
Monoformyl monohydroxymethyl	641	581	556	516	Rhodo
Monocarboxy monovinyl	636	581	550	512	Rhodo
Monocarboxy monohydroxyethyl	634	579	547	510	Rhodo
Monocarboxy monohydroxymethyl	634	578	547	510	Rhodo
Dihydroxymethyl	624	569	529	498	Aetio

Table 1 gives the position of the absorption bands, in chloroform, of a number of new porphyrins (dimethyl esters) which have been prepared in this study.

This work was supported by grants from the National Health and Medical Research Council of Australia.

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HIGH PREVALENCE OF HIGH-LEVEL β-AMINO-*ISO*BUTYRIC ACID EXCRETORS IN MICRONESIANS

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DIFFERENTIAL excretion of β-amino-*iso*butyric acid is under genetic control, and family data indicate that a single major gene pair is responsible for most of the variations[1,2]. High excretors are homozygous for a single recessive gene and low excretors either heterozygous or homozygous for the dominant allele. Striking differences in the prevalence of high excretors in various populations have been demonstrated and it appears that this genetic polymorphism may be of considerable value in anthropogenetic investigations[3,4].

We are particularly interested in utilizing this trait to explore the genetic relationships and origins of various Pacific peoples and this report extends our observations on excretion of β amino-*iso*butyric acid to the Micronesians inhabiting the Marshall Islands. The fact that some of the Micronesians were exposed to considerable radiation in 1954 is of special interest here. It is known that radiation exposure can temporarily at least increase β-amino-*iso*butyric acid excretion[5], and the Marshallese population permits an examination of possible long-term effects of such exposure on β-amino-*iso*butyric acid excretion.

The following information on the radiation exposure and present status of the inhabitants of Rongelap and Utirik was obtained from the reports of the Brookhaven National Laboratory[6], and from Dr. R. A. Conard of Brookhaven National Laboratory.

Micronesian inhabitants of Rongelap and Utirik atolls, Marshall Islands, were accidentally exposed to fallout in March 1954, following the detonation of a high-yield thermonuclear device during experiments at Bikini Atoll in the Pacific Proving Grounds. Sixty-four inhabitants of Rongelap received an estimated dose of 175 r whole-body γ-radiation, 18 Rongelap people on Ailingnae received about half this dosage, and 157 of the people on Utirik received about 14 r whole-body radiation. The exposed people were evacuated to radiation-free islands in the Marshalls. The Utirik inhabitants were repatriated soon after their evacuation when it was determined that the island was safe for habitation. The exposed Rongelapese, as well as some 150 unexposed relatives, were returned to Rongelap in July 1957 when the radiological hazard was judged to have been terminated. There was, however, slight residual radioactivity remaining on the island, and the body burdens of radioactive substances, particularly of cæsium-137 and zinc-65, and urinary excretion of nucleotides has risen in the Rongelapese since their return. Both the originally exposed and the unexposed people now have increased body burden, with no significant differences between the two groups. The body burden of these radionuclides is below the maximum permissible levels.

Rongelap is in the western (Ralik) chain and Utirik in the eastern (Radak) chain of the Marshall Islands. Some differences in language and customs prevail between these two groups, but for most purposes the people of Rongelap and Utirik may be considered to be closely related racially.

Rongelap urines from 65 exposed (including 12 urines from individuals exposed on Ailingnæ), 119 unexposed and 4 unidentified people were collected in plastic bottles containing thymol preservative. The sample represents 75.7 per cent of the population of the village at the time of the visit. The sexes were equally represented, and the ages of the subjects varied from 3 years to more than 70 years. In some cases, several members of the same family were included, and some kinships suitable for genetic analysis were available. Eighteen samples randomly selected on Utirik were also studied. The urines were kept at 4° C. and shipped in refrigerated containers to Seattle for analysis. Studies were completed 2–3 weeks after collection of specimens. Determinations of β-amino-*iso*butyric acid were carried out by high-voltage electrophoresis on paper[7] and creatinine was determined by the alkaline-picrate method.

During the course of the medical evaluation of the Rongelapese by Conard and his associates, the body burdens of nucleotides were determined[6]. Through the courtesy of Dr. S. Cohn of the Brookhaven National Laboratory, who performed these measurements, the body burdens of cæsium-137 and zinc-65

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* Senior Public Health Research Fellow.

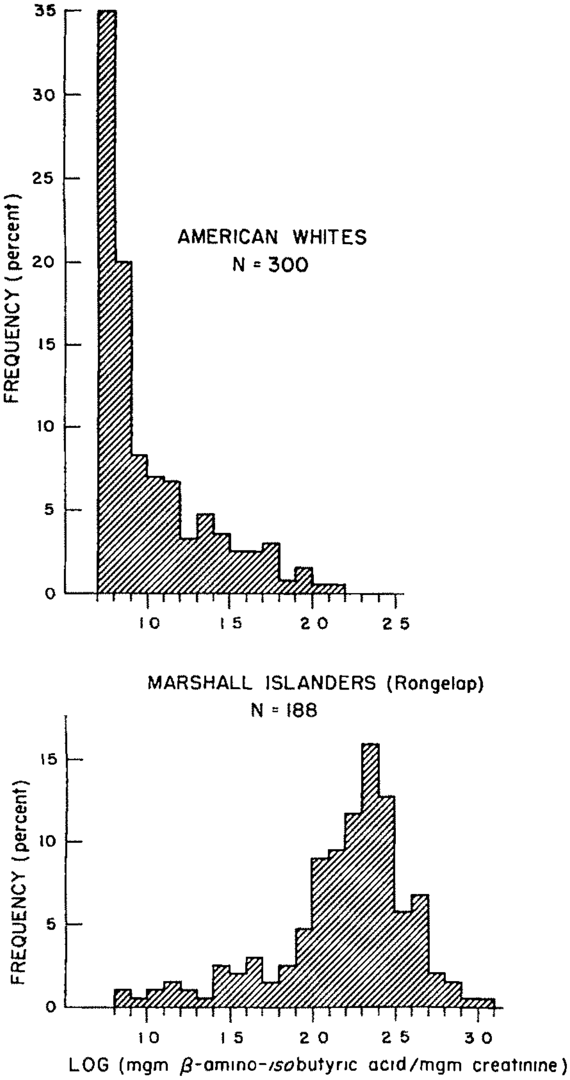

Fig 1 Frequency distributions of urinary excretion-rates of β-amino-*iso*butyric acid of Marshall Islanders (Rongelap) and U S A Whites

of the individuals on whom determination of β-amino-*iso*butyric acid had been made were supplied to us The availability of these data gave us an opportunity to determine if these low levels of radioactivity had any effect on the excretion of β-amino-*iso*butyric acid

In Fig 1 the frequency distribution of β-amino-*iso*butyric acid excretion for the Rongelapese is presented A similar histogram for a New York City white population is included for comparative purposes The two distributions are essentially complementary to one another, and if superimposed exhibit bimodality with the antimode in the neighbourhood of 1 75 Taking this point as the division between high and low excretors, it is estimated that nearly 90 per cent of the Rongelapese are high excretors A breakdown of this population into exposed and unexposed groups shows almost identical mean β-amino-*iso*butyric acid excretion values for the two categories (exposed 2 07 ± 0 06 and unexposed 2 10 ± 0 04) A scatter plot between cæsium-137 levels and β-amino-*iso*butyric acid-level shows no correlation (Fig 2), and a similar plot between zinc-65 levels and β-amino-*iso*butyric acid shows no correlation either The mean β-amino-*iso*butyric acid excretion level for 18 Micronesians, who were on Utirik at the time of the atomic explosion and therefore not exposed to significant radiation, was 2 21 ± 0 13, which is extremely close to the mean value reported for the Rongelapese above 83 per cent of the Utirik people were high excretors, and this is not significantly different from the prevalence in the Rongelap group A number of families are included in the Rongelap data (that is, father, mother and at least one child), and of them the high excretor by high excretor matings are the only ones with significant genetic information There were 11 such matings with a total of 31 offspring (29 high excretors and 2 low excretors) One of the low excretor offspring was illegitimate, as determined by blood group data, leaving one unexplainable exception to genetic hypothesis

Rubini *et al*[5] have recently demonstrated that β-amino-*iso*butyric acid excretion can be a sensitive indicator of radiation exposure The mechanism involved is probably the same as that underlying the effect of nitrogen mustard on β-amino-*iso*butyric acid excretion[8] Such agents markedly increase breakdown of deoxyribonucleic acid, the thymine thus released is effectively converted to β-amino-*iso*butyric acid in man[7,8] and excreted into the urine since no appreciable tubular re-absorption of β-amino-*iso*butyric acid occurs[9] It is unlikely that the high prevalence of high-level β-amino-*iso*butyric acid excretors found in Rongelap is due to radiation The identical average β-amino-*iso*butyric acid values in the exposed and unexposed group precludes the possibility that the elevation is due to the fallout exposure in 1954, and it appears that there is no long-term effect of radiation exposure (at the levels received on Rongelap) on β-amino-*iso*butyric acid excretion The lack of correlation with the cæsium-137 and zinc-65 body burdens rules against the elevation being due to the present radiation-level The nearly identical values in the Utirik group who received a very small dose of radiation, and who have much lower body burdens of radionuclides, is also consistent with the thesis that a high prevalence of the gene underlying β-amino-*iso*butyric aciduria is responsible for the observed β-amino-*iso*butyric acid excretion-rate The expression of the normal genetic difference is probably due to differential metabolism of β-amino-*iso*butyric acid by high and low excretors[9]

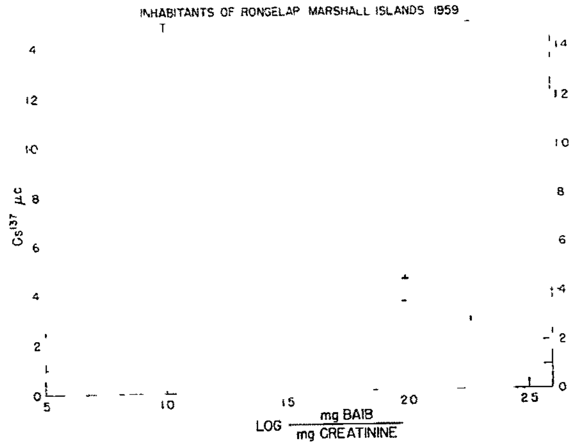

Fig 2 Urinary β-amino-*iso*butyric acid excretion (log mgm β-amino-*iso*butyric acid/mgm creatinine) versus body-load of cæsium-137 (μc)

The level of β-amino-*iso*butyric acid excretion among the Marshallese is the highest yet reported for any population Blood group[10] and other anthropological data on these people suggest a south-east Asiatic origin for them which, if true, predicts a high β-amino-*iso*butyric acid level for the populations of that region Studies of some Asiatic populations have given relatively high β-amino-*iso*butyric acid values, which suggest that there may be an Asian focus for the high β-amino-*iso*butyric acid excretor gene We are at present sampling other Asian populations to determine if this is true and to find some clue to the population dynamics affecting this polymorphism

Table 1. FREQUENCY OF HIGH EXCRETORS IN VARIOUS POPULATIONS

Population	Sample size	Percentage of high excretors	Ref
U S A Whites	218	10 2	11
Alaskan Eskimo	120	23 3	4
Alaskan Athabascan Indians	25	56 0	4
Apache Indians	110	59 2	2
Rongelap Islanders (Marshallese)	188	86 0	—
Utirik Islanders (Marshallese)	18	83 0	—

We are indebted to Dr. R A Conard, Brookhaven National Laboratory, New York, leader of the medical survey to Rongelap, for permission to collect the urines and for his help in completing this study This work was supported in part by a grant (to S M G) from the National Science Foundation (*NSF-G*6187) and the United States Public Health Service (*H*-3091)

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REPLICATION OF TOBACCO MOSAIC VIRUS

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Kinetics of Virus Protein and Ribonucleic Acid Biosynthesis

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PROPOSALS regarding the mode of replication of a virus must be consistent with evidence on the biosynthesis of the virus substance In the case of tobacco mosaic virus, it is known that both the protein and ribonucleic acid parts of the virus ribonucleoprotein are synthesized *de novo* in the infected cell from low molecular weight precursors[1] , but this result places only a relatively slight restriction on theories of replication In the present article we report isotope experiments which describe the rates of synthesis of tobacco mosaic virus protein and ribonucleic acid at various times during the infection process and the biosynthetic origin of protein and ribonucleic acid residues that occur in different parts of the virus rod The results lead to a more detailed characterization of biosynthesis of tobacco mosaic virus and thereby provide further limitations on possible theories of replication of tobacco mosaic virus, the consequences of which are considered in an article which follows

In these experiments nearly mature leaves of *N tabacum* (var White Burley) plants were inoculated with the standard Johnson strain of tobacco mosaic virus and maintained thereafter at constant illumination averaging about 500 foot-candles, and a temperature of 24° C At a given interval after inoculation about 40 gm of blade tissue was removed from the inoculated leaves and exposed to carbon dioxide labelled with carbon-14 (0 07 per cent in air, 33 × 10^6 c p m /mgm carbon) under about 500 ft -candles of illumination for measured periods of time Unlabelled 5 per cent carbon dioxide was then flushed through the system for a period of 10 min The leaf tissue was then frozen in liquid nitrogen and the virus isolated by procedures described previously[2]

Tobacco mosaic virus purified by 6 cycles of alternate low-speed centrifugation (2,500*g*, 1 hr), and ultracentrifugation (105,000*g*, 1 hr), several isoelectric precipitations and dialysis exhibits a constant carbon-14 level on reprecipitation Since the virus protein is 95 per cent of the mass of tobacco mosaic virus and (as will be shown below) the specific activity of virus ribonucleic acid is somewhat less than that of whole virus, the specific activity of whole tobacco mosaic virus may be taken as representative of the specific activity of the virus protein To determine the specific activity of virus ribonucleic acid without interference from tobacco mosaic virus protein it is convenient to convert it to nucleotides For this purpose ribonucleic acid is isolated from the virus by the heat method[3], and hydrolysed in 0 3 *M* potassium hydroxide for 18 hr at 37° C The solution is acidified to *p*H 2, and the nucleotides adsorbed on charcoal, which is then washed twice with distilled water The nucleotides are then eluted from the charcoal by two portions of 1 per cent ammonium hydroxide in ethanol, and separated by paper electrophoresis[4]

The virus content (*V*) per gram (wet weight) of infected leaf was determined by methods described

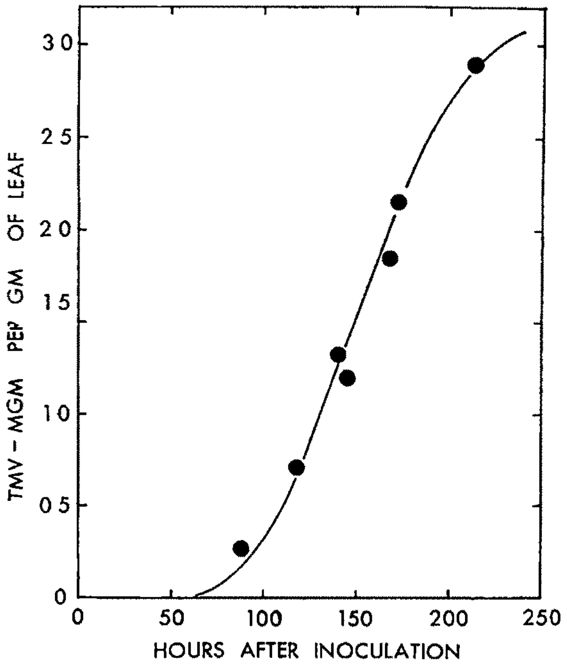

Fig 1 Tobacco mosaic virus content of tobacco leaf tissue at various times after inoculation with tobacco mosaic virus The points are derived from mature leaves removed from separately infected plants at the indicated time after inoculation Plants were maintained at 24° C , and about 500 ft -candles of continuous illumination following inoculation

earlier[5] Fig 1 shows the virus content of the infected leaf at various times after inoculation The curve is a typical one for White Burley tobacco leaves under these experimental conditions[5] From this curve it is possible to estimate the increment in virus content (ΔV) which occurs in the leaf during the time of isotope incorporation Since these times (3–45 min) are very short relative to the overall time-course of virus synthesis (several hundred hours), the amount of new virus synthesized during isotope incorporation is a small part (less than 1 per cent) of the virus present, so that ΔV cannot be measured directly However, the rate of virus formation in the tissue (K_s) can be estimated, for any given time after inoculation, from the slope of the curve of Fig 1 Within the short period of isotope incorporation (Δt) this rate is, in effect, constant, so that ΔV can be estimated from the relationship

$$\Delta V = K_s \, \Delta t \qquad (1)$$

The value of ΔR, the amount of virus ribonucleic acid synthesized during the time Δt, can be determined in the same way, the ribonucleic acid content of tobacco mosaic virus being about 5 2 per cent

Accordingly, for any given infected tissue exposed to labelled carbon dioxide for a period of time, Δt, it is possible to determine the values of V, ΔV, S_v (the specific activity of the total virus), and S_r (the specific activity of virus ribonucleic acid) A series of such measurements have been obtained from virus isolated from leaf tissue which had been removed from infected plants at various times after inoculation, and then exposed to labelled carbon dioxide for one or more periods of time between 3 and 45 min The results, which are plotted in Fig 2, show that within a relatively narrow range of variability, the values of $S_v V/\Delta V$ and $S_r V/\Delta V$ are proportional to Δt if the latter does not exceed 30 min

We may therefore state that .

$$\frac{S_v V}{\Delta V} = K_v \Delta t \qquad (2)$$

and

$$\frac{S_r V}{\Delta V} = K_r \Delta t \qquad (2a)$$

where K_v and K_r are, for the present, designated simply as the relevant constants of proportionality

The significance of this observation is apparent from the following considerations Tobacco mosaic virus, once formed, is metabolically inert[1] Hence, in these experiments only the virus synthesized during the period of isotope incorporation contains carbon-14, and its isotope content is diluted by the pre-existing unlabelled virus Hence

$$S_{\Delta V} = \frac{S_v V}{\Delta V} \qquad (3)$$

and

$$S_{\Delta R} = \frac{S_r V}{\Delta V} \qquad (3a)$$

where ΔV is the amount of virus newly formed in time, Δt, $S_{\Delta V}$ is the specific activity of newly formed virus, and $S_{\Delta R}$ is the specific activity of the ribonucleic acid in the newly formed virus The observations reported in Fig 2 and the empirical relationships expressed in equations (2) and (2a) mean that the specific activities of the total mass of the newly formed virus (which may be equated with its protein) and of its ribonucleic acid increases linearly with the time of incorporation of labelled carbon dioxide K_v and K_r, which are constant with variations in time after inoculation, therefore, represent the rates at which the protein and ribonucleic acid complements of newly formed tobacco mosaic virus increase in specific activity

These conclusions lead to certain further characterizations of the biosynthetic process Since tobacco mosaic virus is metabolically inert, the amount of carbon-14 present in the virus formed during a given period of isotope incorporation (C) is equal to the amount of carbon-14 present in the source material

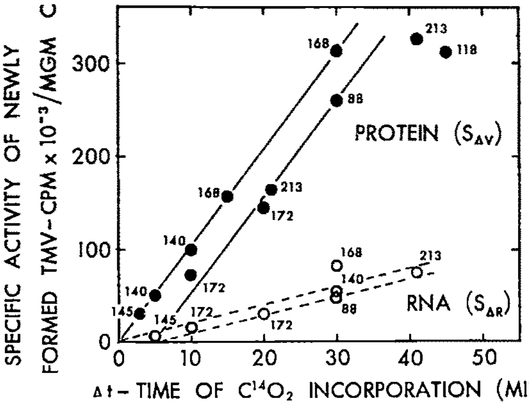

Fig 2 Relationship between the specific activity of protein and ribonucleic acid in newly formed tobacco mosaic virus and time of incorporation of labelled carbon dioxide Specific activity of newly formed protein is determined from the quotient $S_v V/\Delta V$ Specific activity of newly formed ribonucleic acid is determined from $S_r V/\Delta V$ (see text for details) Closed circles, protein values , open circles, ribonucleic acid values Numbers near individual points indicate the number of hours after inoculation with tobacco mosaic virus when leaf tissue was removed from plant and exposed to labelled carbon dioxide Lower solid line and lower broken line indicate maximum intercepts on Δt axis that are compatible with the data Data are derived from tissues described in Fig 1, all of which were cultured under the indicated uniform conditions

converted into virus during that period. Hence C_v will reflect the specific activity, Sp, of the pool of source material. Tobacco mosaic virus is synthesized from material common to the normal cellular metabolic pool, and we may expect the mass of this pool to remain relatively constant during the brief period of incorporation of carbon-14. In this case, Sp will increase from its initial value of zero linearly with Δt, so that

$$Sp = k_v \Delta t \qquad (4)$$

where k_v is the rate of increase in specific activity of the metabolic pool that serves as a source of virus substance.

The rate of change of C_v with time will depend on Sp and on the rate at which substance is transferred from the metabolite pool to virus. The latter rate is identical with the rate of tobacco mosaic virus synthesis, K_s, so that

$$\frac{dC_v}{d\Delta t} = S_p K_s = k_v \Delta t K_s$$

and

$$dC_v = k_v K_s \Delta t \, d\Delta t$$

Therefore, on integration between the limits C_v and $C_v = 0$ and Δt and $\Delta t = 0$

$$C_v = \frac{k_v}{2} K_s \, (\Delta t)^2 \qquad (5)$$

Since the isotope content of the virus is the product of its mass (V) and specific activity (S_v)

$$C_v = S_v V = \frac{k_v}{2} K_s \, (\Delta t)^2$$

However, from equations (1) and (2) it is known also that

$$S_v V = K_v K_s \, (\Delta t)^2$$

so that

$$K_v = \frac{k_v}{2} \qquad (6)$$

Analogous considerations with regard to k_r, the rate at which the metabolic precursors of virus ribonucleic acid increase in specific activity, lead to the conclusion that

$$K_r = \frac{k_r}{2} \qquad (6a)$$

These results show that the empirical observations expressed in equations (2) and (2*a*) are an expected consequence of the kinetic relationships between the tobacco mosaic virus in infected tissue and the metabolic precursors of virus protein and ribonucleic acid. They also serve to specify quantitatively the parameters which connect the rate of increase in specific activity of virus substance, and the rate of increase in the specific activity of its immediate precursors.

The most probable sources of tobacco mosaic virus protein and ribonucleic acid are the free amino-acids and ribonucleotides of the leaf. To test the relationships just described, we have in two instances estimated the values of k_v and k_r by determining the levels of carbon-14 attained by the free amino-acids and ribonucleotides found in virus-infected tobacco leaf after 30-min. periods of incorporation of labelled carbon dioxide.

The source material relevant to virus protein synthesis is that mixture of free amino-acids which is identical in composition to tobacco mosaic virus protein. However, it was possible to isolate in quantities sufficient for analysis of carbon-14 only six free amino-acids, which in aggregate account for 48 per cent of the virus protein. Their specific activities when isolated from two separate batches of leaf after 30 min. assimilation of labelled carbon dioxide are reported in Table 1. The weighted mean specific activities for this amino-acid pool yield an average specific activity, for the two cases, of 600 ± 120 c.p.m. × 10^{-3} per mgm. of amino-acid carbon.

Table 1. SPECIFIC ACTIVITIES OF FREE AMINO-ACIDS ISOLATED FROM TOBACCO MOSAIC VIRUS-INFECTED TOBACCO LEAF

Free amino-acid	Per cent of TMV protein	Preparation I		Preparation II	
		Specific activity (c.p.m. × 10^{-3} per mgm. C)	Specific activity × per cent of TMV protein	Specific activity (c.p.m. × 10^{-3} per mgm. C)	Specific activity × per cent of TMV protein
Aspartic	13.8	331	46	305	42
Glutamic	11.0	942	104	61	7
Serine	6.9	2,332	161	2,181	151
Glycine	2.1	184	4	329	7
Threonine	9.7	254	25	206	20
Alanine	4.8	137	7	62	3
Total	48.3		347		230
Total TMV	100		722		478

Free amino-acids were isolated from extracts prepared by homogenizing frozen leaf tissue after 30 min. of incorporation of labelled carbon dioxide in the light (followed by 10 min. of excess normal carbon dioxide) in 80 per cent ethanol. Amino-acids were purified by adsorption and elution from 'Dowex 50', and then separated by paper chromatography in a phenol–water solvent (*p*H 12). Streaks representing individual spots were localized by means of a ninhydrin spray, and then eluted. Amino-acid content of eluates was determined by Moore and Stein's quantitative ninhydrin method (ref. 10) and an aliquot counted for carbon-14 activity. Individual counts were in the range of 40–6,000 c.p.m., on amounts which varied from 0.4 to 12 μgm. Preparation I was isolated from infected tissue at 126 hr. after inoculation, and Preparation II at 146 hr. after inoculation.

Corresponding results for ribonucleic acid are shown in Table 2. In each experiment it was possible to isolate only two of the required four free ribonucleotides. However, since the specific activities of each nucleotide in the virus ribonucleic acid were determined, the missing values may be estimated on the assumption that the relative specific activities of the nucleotides in ribonucleic acid reflect the differences among the free ribonucleotides. In the two experiments it was found that after 30 min. of incorporation of labelled carbon dioxide, the average specific activity of the pool of free ribonucleotides relevant to biosynthesis of virus ribonucleic acid is 180 ± 60 c.p.m. × 10^{-3} per mgm. carbon.

From the foregoing results we may estimate the values of k_v and k_r as 20,000 ± 4,000 and 6,000 ± 2,000 c.p.m./mgm. of carbon/min., respectively. As indicated earlier, on the assumption that virus protein and ribonucleic acid are synthesized from free amino-acids and ribonucleotides, respectively, these values of k_v and k_r should be twice the values of K_v and K_r.

Table 3 reports the values of K_v and K_r derived from the specific activities of tobacco mosaic virus isolated from the tobacco leaf at various times after inoculation. The values are relatively constant. The mean value of K_v is 8,722 ± 617, the mean value of K_r is 1,818 ± 174 c.p.m./mgm. of carbon/min. Within the range of analytical variation inherent in the rather limited data on free amino-acids and ribonucleotides, these values conform to the relationships expected from the considerations summarized

Table 2. SPECIFIC ACTIVITIES OF FREE RIBONUCLEOTIDES AND OF RIBONUCLEOTIDES ISOLATED FROM TOBACCO MOSAIC VIRUS RIBONUCLEIC ACID FROM INFECTED TOBACCO LEAF

Nucleotide	Molar ratio in TMV RNA	Specific activity—c.p.m. $\times 10^{-3}$ per mgm. C					
		Preparation I			Preparation II		
		Virus RNA nucleotides	Free leaf nucleotides	Specific activity of free nucleotides × molar ratio	Virus RNA nucleotides	Free leaf nucleotides	Specific activity of free nucleotides × molar ratio
Cytidylic acid	18.5	0.065	41	8	0.048	(21)	(4)
Adenylic acid	29.5	1.006	591	174	0.408	176	52
Guanylic acid	26.0	0.175	(103)	(27)	0.325	(140)	(36)
Uridylic acid	26.0	0.248	(146)	(38)	0.075	81	21
Total RNA	100			247			113

Free ribonucleotides were isolated from an extract prepared by homogenizing infected leaf (after 30 min. of incorporation of labelled carbon dioxide in the light and 10 min. of normal carbon dioxide) in 0.6 *M* perchloric acid. Ribonucleotides in the neutralized extract were purified by chromatographic separation on a 'Dowex 1' column. Fractions obtained by this means were then further purified by adsorption and elution from charcoal and by paper electrophoresis, the last two steps being repeated to yield the final sample for carbon-14 determination. Carbon-14 counts were in the range of 6–127 c.p.m.; amounts of nucleotides counted were in the range of 0.40–1.2 μgm. Nucleotides were isolated from tobacco mosaic virus extracted from the same tissue samples according to methods described in the text. Figures in parenthesis are estimated on the assumption that the relative specific activities of the 4 nucleotides in virus ribonucleic acid are in the same proportion as the specific activities of the respective free ribonucleotides.

in equations 1–6*a*. This result tends to validate the biosynthetic mechanism which these equations describe. A major feature of this mechanism of biosynthesis of tobacco mosaic virus is that the rates of synthesis of virus substance from the relevant precursors are identical with K_s, the rate at which tobacco mosaic virus appears in the tissue in its completed extractable form. It would appear, therefore, that throughout the period of the infection process encompassed by our results, tobacco mosaic virus rods are formed about as fast as their protein and ribonucleic acid constituents are synthesized from free amino-acids and ribonucleotides. These observations suggest that throughout the infection process the rates of synthesis of tobacco mosaic virus protein and ribonucleic acid are in the ratio of their respective contributions to the virus mass, and are synchronized with the process which achieves the formation of the completed virus rod.

In an effort to explore further the mechanism of virus synthesis, we have investigated the distribution of carbon-14 in various linear regions of the virus rod. In a previous paper[6] we reported means for the removal of measured linear sections of protein and ribonucleic acid from one end of the tobacco mosaic virus rod. Protein is removed by means of a graded series of treatments in a detergent solution. A corresponding terminal section of the virus ribonucleic acid fibre is thereby exposed, all or part of which can then be removed by incubating the rod in pancreatic ribonuclease or snake venom diesterase.

Some of the labelled tobacco mosaic virus preparations isolated during the course of the foregoing experiments were analysed in further detail by means of this technique. Protein representing measured terminal sections of the total length of the tobacco mosaic virus rod was removed and the carbon-14 specific activities determined. From the differences between the sizes and specific activities of successively larger terminal sections one can calculate the carbon-14 specific activities of serial segments of the rod.

Results of such analyses are shown in Fig. 3. These show that the distribution of carbon-14 in the virus protein is not uniform along the length of the rod. Excess carbon-14 is found in the more distal segments of the rod, especially in the first 5–10 per cent of its length. The disproportionate accumulation of carbon-14 in terminal sections is most pronounced

Table 3. CALCULATION OF RATES OF INCREASE, WITH TIME OF CARBON-14 INCORPORATION, IN SPECIFIC ACTIVITIES OF TOBACCO MOSAIC VIRUS PROTEIN (K_v) AND RIBONUCLEIC ACID (K_r)

Hr. after inoculation	V (mgm. of TMV carbon per gm. leaf)	K_s (mgm. of TMV carbon per hr.)	Δt (min.)	ΔV (mgm. of TMV carbon per gm. leaf)	S_v (c.p.m. per mgm. TMV carbon)	S_r (c.p.m. per mgm. TMV RNA carbon)	$K_v = S_vV/\Delta V\,\Delta t$	$K_r = S_rV/\Delta V\,\Delta t$
88	0.14	0.004	30	0.0020	3,720	676	8,683	1,577
118	0.38	0.013	45	0.0097	8,200	—	7,082	—
140	0.70	0.015	5 10 30	0.0013 0.0025 0.0075	90 360 1,662	— — 550	9,692 10,082 7,262	— — 1,711
145	0.64	0.015	3	0.0007	36	8	10,809	2,438
168	0.98	0.013	15 30	0.0033 0.0065	565 1,920	 520	11,192 9,651	— 2,613
172	1.14	0.012	10 20	0.0020 0.0040	125 480	28 99	7,125 6,840	1,595 1,411
213	1.54	0.005	21 41	0.0017 0.0034	240 535	— 125	10,336 5,910	— 1,381
						Average	8,722 (±617)	1,818 (±174)

V is the virus content of the infected leaf; K_s is the rate of increase in virus content determined from a plot of V against hours after inoculation (see Fig. 1); Δt is the time of incorporation of labelled carbon dioxide in the light (in each case followed by a 10-min. period of incorporation of normal carbon dioxide in the light). ΔV is the increment in virus content during the time Δt, calculated from the values of K_s and Δt; S_v is the specific activity of tobacco mosaic virus isolated from the tissue, which is equivalent to the specific activity of virus protein; S_r is the specific activity of virus ribonucleic acid, determined from the specific activities of the nucleotides isolated from the ribonucleic acid; K_v and K_r are respectively the rate of increase in the specific activities of protein and ribonucleic acid in the newly formed tobacco mosaic virus, and have the dimension c.p.m. per mgm. tobacco mosaic virus carbon per min.

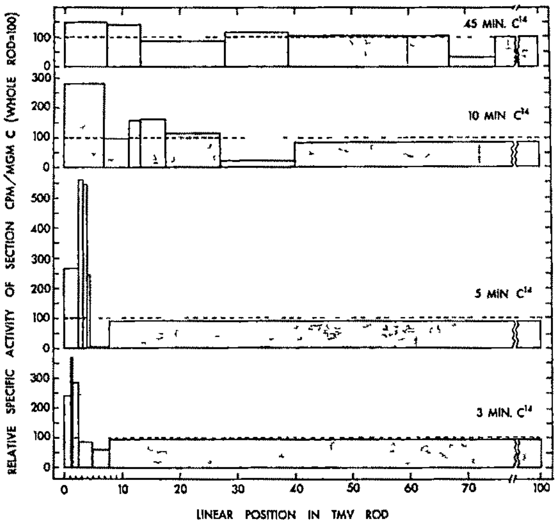

Fig 3 Carbon-14 levels in successive linear sections of virus protein isolated from four tobacco mosaic virus preparations The figure is based on specific activities found in successively longer terminal sections of virus protein removed from tobacco mosaic virus by the procedure described in the text Bars represent specific activities of indicated linear segments calculated from the differences between the specific activities of successively longer terminal segments Linear position is determined from the percentage of total virus protein represented by the given terminal segment

where relatively short periods of labelled carbon dioxide incorporation are employed Where the time of incorporation is longest (45 min) the carbon-14 distribution is nearly uniform

Corresponding investigations of the virus ribonucleic acid fibre were restricted by the relatively small amounts of material available However, single terminal segments of the virus ribonucleic acid representing from 5 to 10 per cent of the total ribonucleic acid fibre have been analysed Results of these experiments, reported in Table 4, show that, like the protein, the ribonucleic acid fibre also exhibits an excess of carbon-14 in the terminal sections

As shown earlier, the specific activity of the precursor materials from which tobacco mosaic virus protein and ribonucleic acid are synthesized increases with time after onset of labelled carbon dioxide Hence the simplest explanation of the excess carbon-14 found in terminal sections of the virus rod is that these sections are synthesized later than the basal portions of the rod This result suggests that the condensation of precursors of low molecular weight to form virus protein and ribonucleic acid occurs in a linear mode, so that biosynthesis represents an increase in the length of the rod Added to the earlier results on the kinetics of virus ribonucleic acid and protein synthesis, this conclusion suggests that tobacco mosaic virus is formed by a process which involves the synchronous extension of both protein and ribonucleic acid in the direction of the long axis of the virus rod

It was the aim of these studies to derive evidence on biosynthesis of tobacco mosaic virus which might help establish new restrictions on theory regarding the mechanism of replication of tobacco mosaic virus In what follows, the characteristics of biosynthesis of tobacco mosaic virus indicated by the foregoing experiments, which relate to this aim, are summarized

(1) *Tobacco mosaic virus is synthesized* de novo The present results confirm earlier observations, based on incorporation of nitrogen-15, phosphorus-32, as well as carbon-14, which showed that synthesis of tobacco mosaic virus occurs *de novo*, in the sense that the proximal sources of virus substance are low molecular weight residues, which are in turn in metabolic contact with carbon dioxide, ammonia and phosphate[1,7–9] The new results represent the shortest time-scales employed in such studies They show that within a 3–5 min period after onset of labelled carbon dioxide, labelled carbon penetrates the entire sequence of biochemical events beginning with carbon dioxide and ending with extractable high molecular weight rods of tobacco mosaic virus nucleoprotein

(2) *The maximum time required for the synthesis of a tobacco mosaic virus rod is about 5 min. ; unfinished virus never exceeds about 0 1 per cent of the tobacco mosaic virus in the leaf* The results in Fig 2 lead to an approximation of the maximum time required to accomplish the unique steps in the biosynthesis of tobacco mosaic virus Generally, virus biosynthesis may be represented by non-specific steps (assimilation of carbon, nitrogen and phosphorus, formation of requisite amino-acids and ribonucleotides) followed by processes uniquely associated with biosynthesis of tobacco mosaic virus, that is, synthesis of specific virus protein and ribonucleic acid, and their assembly into the final virus rod

In their unassembled form, the virus protein and ribonucleic acid may be regarded as pools which are supplied by the relevant metabolite precursors and which are depleted only by formation of the finished tobacco mosaic virus rod Carbon-14 supplied in the form of labelled carbon dioxide must pass through

Table 4 SPECIFIC ACTIVITIES OF TERMINAL SEGMENTS AND RESIDUAL PORTIONS OF TOBACCO MOSAIC VIRUS PROTEIN AND RIBONUCLEIC ACID

TMV preparation	Mgm TMV (per gm tissue)	Min of $^{14}CO_2$	Protein			RNA		
			Length of terminal segment removed (per cent)	Specific activity of terminal segment (c p m per mgm C)	Specific activity of residual portion (c p m per mgm C)	Length of terminal segment removed (per cent)	Specific activity of terminal segment (c p m per mgm C)	Specific activity of residual portion (c p m per mgm C)
1 *A*	2 2	10	14 4	150	123	11 6	96	28
1 *B*	2 2	20	13 5	744	474	11 1	640	99
3	1 9	30	9 8	2,537	1,904	6 6	1,650	540
4	2 9	40	13 3	730	507	8 9	312	90

Protein segments were obtained by the method described in the text The terminal segment represents the low molecular weight protein sub-units which are separated from the residual high molecular weight protein of the virus rod by ultracentrifugation The length of the terminal segment is determined by Folin analysis of the protein content of the ultracentrifuge supernate Ribonucleic acid terminal segments were removed by treating protein-stripped rods with snake venom diesterase, the percentage of ribonucleic acid removed was determined from the nucleotide content (measured by ultra-violet absorption) of the ultracentrifuge supernate after the enzyme treatment Ribonucleic acid was extracted from the residual portion of the virus rod by the heat method Both terminal and residual ribonucleic acid were converted to nucleotides, and the carbon-14 contents determined as described in the text Counts of separate protein samples were in the range 7–96 c p m The range for ribonucleic acid samples was 2–44 c p m these pools before it appears in tobacco mosaic virus nucleoprotein. When the time of labelled carbon dioxide assimilation, Δt, is sufficiently long, the carbon in these pools approaches the specific activities of the materials entering them. When Δt is very small, the unlabelled substance of the pool of unassembled parts dilutes the entering isotope so that the pool's specific activity is appreciably less than that of the entering material.

As already indicated in these experiments the specific activity of metabolites increases with Δt. In these circumstances we may expect the specific activity of the pool of unassembled parts to increase at a rate which is proportional to that of the entering material when Δt is relatively large. However, when Δt is very small, the specific activity of the pool substance will increase at a smaller and accelerating rate. These effects will be reflected by the specific activity of the newly formed virus, which may be viewed as an aggregate of unassembled parts.

This means that in a plot of $S_{\Delta V}$ (or $S_{\Delta R}$) against Δt, such as Fig. 2, the initial part of the curve should show an accelerating rate of increase in $S_{\Delta V}$ which finally becomes constant. The intercept of the linear part of the curve on the Δt axis is an estimate of the time required for the pool of unassembled parts to approach the specific activity of its precursors. This value is, approximately, the average time which carbon entering the pool spends in it before leaving as a completed tobacco mosaic virus rod. In general, the intercept approximates the time required to synthesize the virus protein and ribonucleic acid and to assemble them into the tobacco mosaic virus rod, although no exact relationship can be given without knowing the mechanisms involved.

It is clear from Fig. 2 that given the experimental errors involved in determining $S_{\Delta V}$, the expected intercept is so close to zero as to be unascertainable. However, the results do permit an estimate of the largest intercept consistent with them. This is shown in Fig. 2 as the lower lines drawn through the protein and ribonucleic acid values. For both $S_{\Delta V}$ and $S_{\Delta R}$ the maximum intercept is about 5 min. The time required to synthesize a tobacco mosaic virus rod (t_a) is therefore between zero and 5 min.; considerably more refined measurements will be needed for a closer approximation of the true value. The time for rod synthesis lies between these limits throughout the period of the infection process that was studied.

The maximum value of t_a (that is, 5 min.) defines the maximum size of the pool of unassembled virus components (P), since $P = K_s t_a$. At 140 hr. after inoculation, when K_s is at a maximum (0·015 mgm. of tobacco mosaic virus carbon per gm. of leaf per hr.), the maximum value of P is about 0·001 mgm. of carbon per gm. of leaf, or about 0·1 per cent of the tobacco mosaic virus present.

Thus, the individual biosynthetic event appears to be very short compared to the time-scale of the overall course of tobacco mosaic virus synthesis in infected tissue (Fig. 1). This suggests that the observed variations in the total rate of tobacco mosaic virus synthesis with time after inoculation reflect changes in the number of active biosynthetic sites in the leaf. The virus enters the leaf through relatively few cells, the infection spreading radially from these foci[11]. It is to be expected, then, that with increasing time after inoculation the number of cells in which tobacco mosaic virus biosynthesis is active will at first increase exponentially, reach a maximum and then decline as the leaf becomes fully infected, and the first-infected cells stop forming virus. The amount of unassembled virus parts, though very small, is expected to vary in proportion to the changing number of biosynthetically active sites.

(3) *Virus protein and ribonucleic acid complements are synthesized from their respective precursors (free amino-acids and ribonucleotides) concurrently, at approximately equal rates.* Fig. 2 shows, from isotope data, that the rate of biosynthesis of the virus protein and ribonucleic acid complements are proportional to each other throughout the period of the infection process included within the period 88–213 hr. after inoculation. This relationship is expressed more explicitly in Fig. 4, which includes in addition to the data of Fig. 2, further observations made with infected tissue cultured under conditions different from those employed in the major part of our experiments. It was found also that the ratio between the carbon-14 levels of protein and ribonucleic acid isolated from a given preparation of labelled virus approximates the ratio of the specific activities of the amino-acids and ribonucleotides found in the infected leaf. It would appear, then, that the protein and ribonucleic acid complements of a given tobacco mosaic virus rod are synthesized at approximately equal rates, or considered as mass of substance, at rates which are in the approximate ratio in which the substances occur in tobacco mosaic virus. Since the carbon-14 level varies with time of labelled carbon dioxide assimilation this relationship may be expressed in temporal terms as well. In effect, the observations show that the protein and ribonucleic acid found in the virus newly formed during the course of the isotope experiment are synthesized from their respective low molecular weight precursors at about the same time. This result, together with the preceding conclusion, means that the formation of tobacco mosaic virus in its final form is synchronized with the concurrent biosynthesis of its constituent protein and ribonucleic acid from their respective low molecular weight residues.

(4) *At least near one end of the rod tobacco mosaic virus protein and ribonucleic acid are synthesized by a*

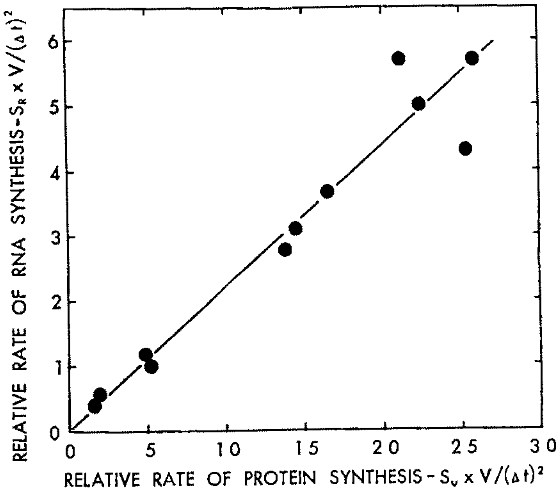

Fig. 4. Relative rates of tobacco mosaic virus protein and ribonucleic acid synthesis as determined from the respective specific activities. These data include those presented in Fig. 2, together with additional points derived from tobacco mosaic virus preparations isolated from leaves cultured under conditions different from those described in the legend for Fig. 1

process of linear extension This conclusion follows from the disproportionate distribution of carbon-14 among the protein sub-units found in successive positions along the length of the rod While the ribonucleic acid data are lacking in detail, they indicate that both virus protein and ribonucleic acid exhibit parallel linear variations in carbon-14 levels When added to the earlier results, this suggests that the ribonucleic acid and protein found in a given segment of the rod are probably synthesized concurrently from their precursors

These conclusions set certain limitations for possible mechanisms of tobacco mosaic virus replication In the following article proposed explanations of tobacco mosaic virus replication are re-examined with regard to the degree to which they conform to these requirements

The work reported in this article was supported by grants from the Rockefeller Foundation and from the National Foundation We wish to thank Mrs Ellen E Richman and Miss Clarice Strode for assistance in this work, and Dr Thomas Hollocher for suggestions regarding the treatment of kinetic data

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A Re-examination of Theories

By PROF. BARRY COMMONER

THE preceding article has presented evidence, derived from isotope studies of the biosynthesis of tobacco mosaic virus, which places certain restrictions on proposals regarding the mode of replication of this virus In the present article the implications of these new requirements for the theory of tobacco mosaic virus replication are considered

Tobacco mosaic virus is a hollow cylinder composed of a single fibre of ribonucleic acid held in a helical form in the interstices between sequential turns of a helical array of ovoid protein sub-units, each of molecular weight 17,000–18,000 (ref 1) The empirical datum of replication is that infection of a suitable cell by a tobacco mosaic virus rod results in the biosynthesis of new rods which resemble the inoculum

The evidence reported in the preceding article leads to the following conclusions regarding tobacco mosaic virus biosynthesis (1) The protein and ribonucleic acid found in a given virus rod, and probably in a given linear segment of the rod, are formed concurrently from low molecular weight precursors (2) The time required to synthesize a tobacco mosaic rod is not more than about 5 min (3) The amount of unfinished virus in the leaf never exceeds about 0 1 per cent of the completed tobacco mosaic virus present (4) The disproportionate distribution of carbon-14 incorporated into ribonucleic acid and protein found in successive linear segments of the virus rod suggests that the rod is formed by a process of linear extension (5) These relationships hold for the time 88–213 hr after inoculation, a period in which most of the virus that infected tissue can produce appears in an extractable form Changes in the total rate of tobacco mosaic virus synthesis (per gm of leaf) that occur during this period reflect corresponding changes in the number of sites of tobacco mosaic virus biosynthesis, resulting from the spread of the infection among the leaf cells

Consideration of some general attributes of protein and ribonucleic acid biosynthesis adds further particulars to this specification of the spatial and temporal relationships that govern the replication of tobacco mosaic virus Comparison of isotope-levels of amino-acids and ribonucleotides found free in the infected leaf with those in the newly formed tobacco mosaic virus nucleoprotein indicate that these residues are closely related, and perhaps identical, to the precursors of virus protein and ribonucleic acid Current biochemical evidence concerning protein synthesis in general indicates that polymerization of amino-acid residues to form protein occurs in close connexion with ribonucleic acid[2] This suggests that the specific amino-acid sequence in tobacco mosaic protein is governed by the structure and nucleotide sequence of a specific ribonucleic acid In the absence of contrary data, it is simplest to assume that this ribonucleic acid is the virus ribonucleic acid

Thus, in the synchronous linear synthesis of virus ribonucleic acid and protein, the specificity of one part of the process, protein synthesis, depends on the character of the second component, ribonucleic acid However, if the matter is pursued further, we find that the biochemical competence of the virus ribonucleic acid in turn appears to depend on the virus protein

Formal evidence to support this view can be derived from the structure of tobacco mosaic virus Each tobacco mosaic virus rod contains a single fibre of ribonucleic acid A single strand of polynucleotide is incapable of maintaining a specific secondary structure Once released from the constraints imposed by the surrounding protein sub-units, the virus ribonucleic acid collapses into a random coil in which hydrogen bonds serve to bind various segments of the fibre to one another[3] Randomly coiled fibres, which comprise the greater part of ribonucleic acid preparations, are probably biologically inactive[4]

If virus ribonucleic acid is to regulate the specific sequence of amino-acids found in tobacco mosaic virus protein, it must meet two requirements (1) the ribonucleic acid fibre must be accessible to the approach of suitably activated amino-acid residues, (2) the ribonucleic acid fibre must retain a specific secondary structure, to ensure that a given region of the fibre will present a specific chemical configuration to the approaching residues

Ribonucleic acid contained within the virus rod fulfils the requirement for structural specificity but is not accessible to the approach of protein precursors On the other hand, ribonucleic acid freed from the tobacco mosaic virus rod has the necessary accessibility to metabolites, but being a single strand is subject to structural collapse and thereby fails to provide for configurational specificity

There is a possible escape from this dilemma that the germinal competence of virus ribonucleic acid is associated with a segment of the fibre which is attached to an underlying array of protein sub-units. In this condition the ribonucleic acid fibre, or at least a part of it, is both accessible and specifically structured. Such a configuration can be achieved, for example, by removing the terminal layer of protein sub-units from an end of the virus rod. This exposes the terminal turn of the ribonucleic acid fibre, which, being bound to the underlying protein sub-units, can retain its normal structural arrangement.

In this view, virus ribonucleic acid regulates the specificity of protein synthesis but can function in this way only when its own configuration is established by attachment to virus protein. The biological competence of tobacco mosaic virus would then depend mutually on protein and ribonucleic acid.

At first glance this view would appear to be disproved by the observations that ribonucleic acid preparations isolated from tobacco mosaic virus are slightly infectious, while purified preparations of tobacco mosaic virus protein are wholly inactive[5]. However, on closer examination the situation is seen to be somewhat different. While there is considerable evidence that ribonucleic acid is necessary for the infectivity of these preparations (for example, inactivation by ribonuclease), there is as yet no evidence that it is *alone* sufficient for biological activity. The infectivity-levels of isolated ribonucleic acid preparations are two orders of magnitude less than those exhibited by either natural tobacco mosaic virus nucleoprotein, or by reconstituted nucleoprotein. Ribonucleic acid preparations are heterogeneous by several criteria, the major part of the infectivity being associated with a component that represents about 1–10 per cent of the ribonucleic acid present[4]. Takahashi *et al.*[6] find that the most infectious electrophoretic fractions of ribonucleic acid preparations also contain the greatest amounts of associated protein. If it is assumed that in a ribonucleic acid preparation only those fibres which are associated with some protein are biologically active, the protein content of such preparations is sufficient to account for the presence of 4–50 protein sub-units per active ribonucleic acid strand[7]. It can be shown also that the low infectivity of ribonucleic acid preparations is not due to inefficient invasiveness resulting from susceptibility to degradative enzymes. Reconstitution, which restores the proper ribonucleic acid configuration, contributes directly to infectivity rather than simply protecting the inherent activity of the ribonucleic acid from inactivation during invasion[8]. Furthermore, when part of the virus protein is removed, so that the ribonucleic acid fibre becomes susceptible to enzymatic attack *in vitro*, the rod retains a relatively high level of infectivity[9].

The available evidence suggests that virus ribonucleic acid, like tobacco mosaic virus protein, is a necessary but not sufficient condition for virus activity. At the least, there is in these data no commanding reason to preclude the proposal that the biological activity of tobacco mosaic virus, or of infectious materials derived from it, depends jointly on the presence of intact fibres of ribonucleic acid, and at least a few protein sub-units.

These considerations may be summarized as follows: (*a*) the experimental data on biosynthesis show that tobacco mosaic virus formation involves the synchronous extension of the virus ribonucleic acid fibre and of its helical array of protein sub-units; (*b*) the structural properties of tobacco mosaic virus and its constituents suggest that replication requires the specific participation of both virus ribonucleic acid and protein.

These conclusions preclude any proposal regarding tobacco mosaic virus replication that requires asynchrony greater than a few minutes between the synthesis of ribonucleic acid and protein found in a given virus rod, or the accumulation of unassembled virus parts in amounts which are significant relative to the tissue's content of completed virus. A recent proposal of this type based on determination of the biological activity of differential extracts of infected leaf is that a store of infectious ribonucleic acid accumulates 10–50 hr. after inoculation, being later depleted as virus protein is synthesized and condensed around the ribonucleic acid fibres[9]. The isotope data described in the preceding article show that a replicative process of this type cannot account for the tobacco mosaic virus produced 88–213 hr. after inoculation, when the greater part of the virus appears in tissue extracts. It is possible that two different types of replication occur, the earlier one being governed by asynchronous synthesis of virus ribonucleic acid and protein. Isotope data on this phase of the virus growth curve, which are not available as yet, may help to resolve the discrepancy.

An alternative type of replicative scheme, proposed in a preliminary form in an earlier publication[10], conforms more closely to the requirements discussed above. This scheme is not complete, and does not describe the initial phases of the replication process, that is, the events initiated in the cell by the entering inoculum. Rather, the scheme relates only to those phases of replication in which the bulk of the virus found in infected leaf is synthesized from low molecular weight precursors.

This scheme proposes that in tobacco mosaic virus replication the germinal agent may be represented by a single turn of the virus ribonucleic acid fibre attached to a layer of protein sub-units. This structure becomes accessible when a terminal layer of protein units is removed from one end of the tobacco mosaic virus rod, a process which might represent the first step in infection. Where infection is induced by a ribonucleic acid preparation, the agent of infection might be represented by a terminal segment of a ribonucleic acid fibre which remains attached to several protein sub-units, thereby providing an arrangement similar to that found at the exposed end of a tobacco mosaic virus rod.

Fig. 5*A* is a schematic representation of such a structure. It shows a single turn of the ribonucleic acid helix, comprising 48 nucleotides, attached to the surface of the 16 1/3 protein sub-units which also comprise a single turn. In this arrangement the structural configuration of the ribonucleic acid fibre is determined by its attachment to the surfaces of the protein sub-units.

Fig. 5*B* represents the second phase of the proposed process, in which amino-acid residues in an appropriately activated form become attached to the exposed segment of ribonucleic acid. It is presumed that the sequence of amino-acids bound to the ribonucleic acid segment will depend on the nucleotide sequence in the segment, and on its configuration. The diameter of the ribonucleic acid helix is about 80 A., and the contour length of a single turn is about 250 A. A polypeptide chain in the configuration of an α-helix has an axial translation of 1.5 A. per residue, so that a helix 250 A.

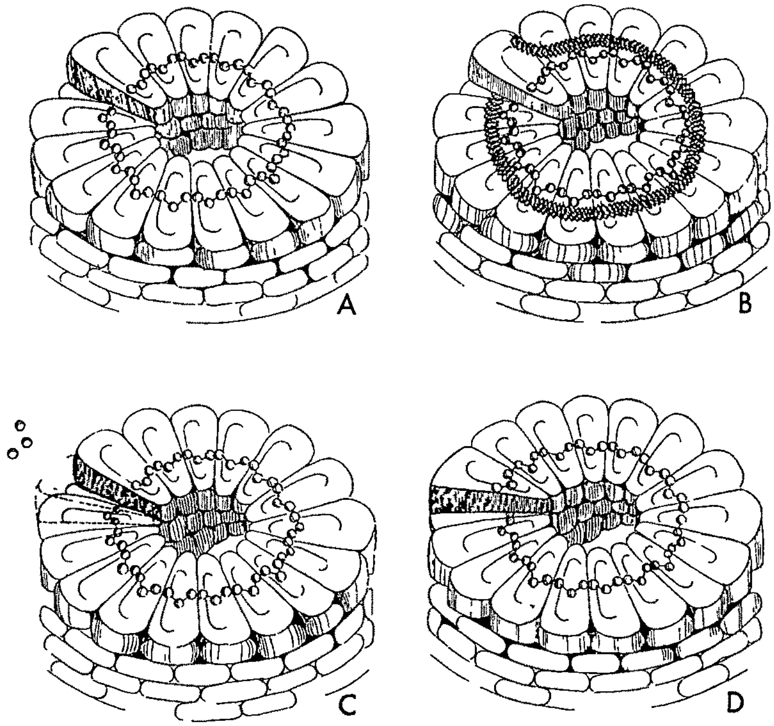

Fig. 5. Drawings to illustrate successive stages in the scheme of biosynthesis of tobacco mosaic virus proposed in the text. The view represents the end of a tobacco mosaic virus rod in process of formation. Sectional segments represent protein sub-units, small spheres represent the ribonucleotide residues, and the helical structure in *B* represents the polypeptide chain of a single protein sub-unit in the configuration of an α-helix. The drawings are schematic and only approximately to scale. Indications of surface structure on the protein sub-units are wholly arbitrary.

long overall will contain about 167 residues[11]. Hence a single turn of the virus ribonucleic acid fibre will accommodate a polypeptide α-helix comprising about 167 amino-acid residues. This is the approximate size of the polypeptide unit contained in a single virus protein sub-unit. It is proposed, then, that a single turn of the virus ribonucleic acid fibre provides the locus for the initial polymerization of the amino-acids found in a single virus protein sub-unit.

Fig. 5*C* illustrates the results of the next stage in the proposed scheme, in which the newly formed polypeptide chain becomes detached from the ribonucleic acid fibre and, after suitable folding, assumes the tertiary configuration characteristic of the virus protein sub-unit. It will be noted that the terminal sub-unit represents a step dislocation in the crystal-like array of protein sub-units[12]. It is proposed that the newly formed sub-unit takes its place at the step dislocation, thereby extending the helical array by an additional member. The newly formed sub-unit becomes the terminal unit in the rod, but unlike the other units is not, at first, associated with attached ribonucleic acid. Furthermore, as it falls into place the new sub-unit covers the three proximal nucleotides of the terminal ribonucleic acid segment.

It is proposed, next, that the ribonucleic acid chain is extended by the terminal acquisition of three new nucleotides. These become added to the ribonucleic acid fibre and, being bound to the free surface of the last-formed protein sub-unit, assume the appropriate structural configuration. In this manner the terminal exposed section of the ribonucleic acid fibre is restored to its full complement of 48 nucleotides (see Fig. 5*D*).

Comparison of Figs. 5*A* and 5*D* shows the overall result of the proposed process: both the ribonucleic acid fibre and the helical array of protein sub-units have been extended lengthwise by synchronous synthesis from amino-acid and nucleotide residues. Repetition of this process accomplishes a progressive lengthening of the virus rod. The process is, however, not a uniformly repetitive event. The synthesis of each new protein sub-unit and the subsequent extension of the terminal ribonucleic acid segment causes a change in the nucleotide composition of the exposed ribonucleic acid segment. In each replicative event this segment loses three nucleotides at one end, and gains three nucleotides at the other end. Thus, the formation of each protein sub-unit alters, slightly, the nucleotide sequence of the segment of ribonucleic acid which governs the synthesis of the next protein sub-unit. This change might, for example, be reflected in a slight variation of the amino-acid sequence in the next protein sub-unit that is formed. In turn, the altered structure of the newly formed protein sub-unit might influence the choice of the new nucleotides that become attached to its surface when the ribonucleic acid fibre is extended. Such a cyclical interaction between successive biosynthesis of protein sub-units and of extension of the ribonucleic acid fibre could result in a gradual and harmonic variation in the composition of both components. One result of this process may be the appearance of periodic weak points which disrupt the extension of the virus rod, thereby detaching tobacco mosaic virus rods of a given length.

The foregoing scheme provides for the simultaneous synthesis of virus ribonucleic acid and protein from low molecular weight residues. It proposes a linear extension of both the ribonucleic acid and protein parts of the virus. In these respects it provides a model which is in keeping with the experimental observations on the biosynthesis of tobacco mosaic virus protein and ribonucleic acid described in the preceding article.

Certain features of the proposed mechanism may be of interest apart from their possible applicability to tobacco mosaic virus replication. Most proposals regarding the mechanism of nucleic acid replication, especially those derived from the proposed double-helical structure of deoxyribonucleic acid[13], have two chief distinguishing features. (1) Replication is conceived to occur in a mode which is lateral to the nucleic acid fibre, the ordering of new nucleotide residues being accomplished by forces, extended in a lateral direction, which lead to the establishment of specific hydrogen bonds[14]. (2) The nucleic acid is supposed to be a self-sufficient agent, neither protein nor any other genetically specific substance being required for the replicative process Configurational specificity is inherent in the double-stranded structure, which unlike a single polynucleotide fibre can maintain a rigid geometrical arrangement This structure is itself a hindrance to the accessibility toward approaching nucleotide residues that is a necessary prelude to replication, and various hypothetical schemes have been put forward to permit such access without undue loss of configurational stability[14]

The general features of the replicative scheme described in Fig 5 contrast with the above (1) The ribonucleic acid fibre is single, and is therefore not capable of achieving a specific configuration apart from association with protein (2) Replication of the ribonucleic acid fibre is viewed as a linear process Duplication of the original fibre's nucleotide sequence is not accomplished by direct lateral complementarity, but by the instigation of the required pattern of selection of new terminal nucleotides (3) Replication of the ribonucleic acid fibre is not a self-sufficient property of ribonucleic acid itself, but depends on the participation of protein This requirement emerges directly from the single-stranded character of the ribonucleic acid fibre It also results from the need for a mechanism which can provide for specific selection of terminal nucleotides

In the proposed scheme for linear replication of tobacco mosaic virus specific nucleotide selection may be provided as follows The protein sub-unit acquires an amino-acid sequence which reflects the nucleotide sequence of a given segment of ribonucleic acid The sub-unit's tertiary configuration, we may assume, is in turn dependent on this amino-acid sequence, so that the surface properties of the sub-unit are indirectly determined by the nucleotide sequence in the ribonucleic acid segment Finally, the specific properties of the protein sub-unit surface are the means for determining the identity and sequence of the three new nucleotides added to the ribonucleic acid fibre. Hence, in this view the sequence of forty-eight nucleotides in the terminal segment of the ribonucleic acid fibre determines the sequence of three nucleotides added to the free end of the segment; but in this determination the protein sub-unit serves as a genetically specific, and essential, intermediate. From information theory it should be possible to derive suitable quantitative rules for the determinative properties of such a system

This type of replicative scheme is specifically adapted to the participation of a single-stranded polynucleotide In this connexion its applicability to the single-stranded form of deoxyribonucleic acid recently discovered in a bacteriophage[15] may be of interest

The foregoing scheme may be cast in alternative forms. One such form[7] proposes that the protein sub-unit by analogy with the reading head of a tape recorder "serves as a movable unit which 'reads' or develops the structure of the otherwise structureless ribonucleic acid as it becomes associated with successive portions along the length of the nucleic acid chain"

The proposed scheme offers a possible explanation for the relationships between the amounts of ribonucleic acid and protein in tobacco mosaic virus The virus rod contains a ribonucleic acid fibre made of about 6,000 nucleotide residues and about 2,000 protein sub-units If it is assumed that all the protein sub-units are wholly identical with respect to amino-acid sequence, then the replicative information required to specify the whole protein structure of tobacco mosaic virus relates only to the number of amino-acid residues in a single sub-unit—about 150 Clearly the 6,000 nucleotide sequence of the total ribonucleic acid fibre is an excessively complex source of determinative information for this purpose On the other hand, if each protein sub-unit were unique with regard to amino-acid sequence the nucleotide sequence in a single ribonucleic acid fibre would be insufficient to serve as a determinative agent for the entire assemblage of 2,000 sub-units Reality may lie somewhere between these two extremes , that is, protein sub-units have a considerable part of their amino-acid sequences in common, but differ in some respects This condition is consistent with the scheme described in Fig 5

The foregoing discussion shows that both the new results on the course of tobacco mosaic virus biosynthesis, and consideration of the relation between the structure of tobacco mosaic virus and the formal requirements of replication, place similar restrictions on theories of replication The major requirement is that in tobacco mosaic virus replication biosynthesis of virus protein and ribonucleic acid, and formation of their specific structural arrangement in the virus rod, proceed in synchrony A formal consideration of the geometry of the tobacco mosaic virus rod shows that there is no way of meeting this requirement other than by means of linear extension of the tobacco mosaic virus rod Linear analysis of isotope distribution within the rod offers the first direct experimental evidence that tobacco mosaic virus biosynthesis may proceed in this fashion However, these results, like those which tend to support alternative schemes, are insufficiently detailed or decisive to establish a specific explanation of the mechanism of tobacco mosaic virus replication It is to be hoped that the more detailed requirements which can now be placed on proposed mechanisms of tobacco mosaic virus replication will suggest new experiments which may provide evidence that favours decisively one proposal or another

The preparation of this and the preceding article has had the benefit of valuable discussions with Dr Alfred M Holtzer I wish to acknowledge also the support of grants from the National Foundation and the Rockefeller Foundation

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Biologischen Bundesanstalt fur Land- und Fortswirtschaft, Berlin-Dahlem Mitteilungen Heft 95 (März, 1959) Zur Toxikologie der Insektizide Literaturubersicht 1 Teil Dien-Gruppe Von Dr P Steiner und Dr W Gruch Pp 118 9 70 D M Heft 96 (Mai, 1959) Biologische Untersuchungen uber die Entwicklung von *Hylotrupes bajulus* L (Hausbockkäfer) Von Dr A Korting Pp 35 3 60 D M Bibliographie der Pflanzenschutzliteratur, 1952 (Bibliography of Plant Protection, 1952) Bearbeitet von Dr J Bärner Pp xii+433 43 D M (Berlin-Dahlem Biologische Bundesanstalt fur Land- und Forstwirtschaft, 1959) [411

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO, LTD,
ST MARTIN'S STREET, LONDON, W C 2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare London

Annual subscription £7/15/–, payable in advance, postage paid to any part of the world

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NATURE

A WEEKLY JOURNAL OF SCIENCE

"To the solid ground
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20/6/60.

Volume ~~185~~ 184

JULY 4, 1959, to DECEMBER 26, 1959

LONDON
MACMILLAN AND CO., LTD.
NEW YORK. ST. MARTIN'S PRESS, INC.

DATES and PAGINATION of WEEKLY ISSUES

Serial	*Date of issue*		*Pagination*
4679	July	4	1–80
4680	,,	11	81–126
4681	,,	18	127–210
4682	,,	25	211–294
4683	August	1	295–382
4684	,,	8	383–482
4685	,,	15	483–568
4686	,,	22	569–658
4687	,,	29	659–746
4688	September	5	B A 1–84
4689	,,	12	747–834
4690	,,	19	835–918
4691	,,	26	919–1004
4692	October	3	1005–1086
4693	,,	10	1087–1170
4694	,,	17	1171–1258
4695	,,	24	1255–1342
4696	,,	31	1343–1430
4697	November	7	1431–1518
4698	,,	14	1519–1594
4699	,,	21	1595–1670
4700	,,	28	1671–1746
4701	December	5	1747–1826
4702	,,	12	1827–1896
4703	,,	19	1897–1970
4704	,,	26	1971–2042

INDEX

References to B A pagination indicate the issue for September 5, 1959

ABAELU, J N (Moore, Dr A W, and) Non-Symbiotic Nitrogen Fixation in a Soil of the Nigerian Rain-Forest Zone, 75
Abdel Moneim, F, and others *In vitro* Study of the Anthelminthic Property of *Artemesia monosperma* grown in Egypt, 647
Abdel-Samie, Y, and others Production of Serum Albumin and of Globulins by Chick Mesenchymal Tissue and by HeLa Tumour Tissue in Culture, 361, *erratum*, 943
Abe, Matazo, and others Microbiological Transformation of a Cardiac Aglycone, 469
Abel, Dr E W Lectureship in inorganic chemistry in the University of Bristol conferred on, 410
Abelson, Philip H (edited by) Researches in Geochemistry, *review* by Dr S R Nockolds, 1757
Abercrombie, Michael Title of professor of embryology in the University of London (at University College) conferred on, 1451
Åberg, Prof B, and others Fate of Injected Dextran Labelled with Tritium in Mice, 373
Abnormal Haemoglobin (New Fast), in Newborn Nigerians (Dr A E Boyo and R G Hendrickse), 997
Abnormal Haemoglobins—a Symposium organized by the Council for International Organizations of Medical Sciences (edited by J H P Jonxis Delafresnaye), *review* by Dr J A M Ager, 840
Abnormal Human Haemoglobins—Human Haemoglobin E, the Chemical Effect of Gene Mutation (Dr J A Hunt and Dr V M Ingram), 870, Haemoglobin 'Bart's', a Foetal Haemoglobin without α-Chains (Dr J A Hunt and Dr H Lehmann), 872
Abnormalities (Floral), in Broccoli (D R Sampson and M MacArthur), 682
Abnormality (A Chemical), in Haemoglobin G (Dr Robert L Hill and Dr Herbert C Schwartz), 641
Abo Blood Groups and Fertility in a Normal American Population An Association between (Dr T Edward Reed and Dr J H Ahronheim), 611
Abolition by Chlorpromazine of the Inhibiting Effect of Iproniazid on the Depletion of Adrenal Catechol Amines induced by Reserpine (F Camanni, Dr G M Molinatti and M Olivetti), B A 65
Abood, L G, and Koketsu, K Excitability and Phosphorylation of Muscle and Nerve in Sodium-free Hydrazinium Solution, 725
Abortion (Ovine), due to Toxoplasmosis (Dr J K A Beverley and W A Watson), 2041
Abragam, Prof A Spin Temperature (Holweck Lecture of the Physical Society), 954
Abrahamson, E W Fast Chemical Reactions in Solution (Visual Pigments), 1453
Abrasion of Solids such as Metals A Theory of the (J Goddard H J Harker and H Wilman), 333
Abreu, Luiz A, and Abreu, R Raposo Determination of Tissue Mucoproteins, 2016
Abreu, R Raposo (Abreu, Luiz A, and) Determination of Tissue Mucoproteins, 2016
Abrogation by Injected Mouse Blood of Protective Effect of Foreign Bone Marrow in Lethally X-Irradiated Mice (L J Cole and R M Garver), 1815
Absence of Craters on the Far Side of the Moon (David B Beard), 1631
Absence of Ectodermal Ridge Limb Development in the (Dr Eugene Bell, Dr John W Saunders, jun, and Dr Edgar Zwilling), 1736
Absence of Metabolic Energy Supply Maintenance of Semipermeability of Plant Cell Membranes in the (Dr B Ginzburg), 1073
Absence of Serum Factor Transformation Reaction of Pneumococci in the (Prof Takeshi Odaka and Tadashi Watanabe), 471
Absence (Hereditary), of the Spleen in the Mouse (A G Searle), 1419
Absolute Requirement for 'Iron Transport Factors' by *Microbacterium lacticum* 8181 (Dr D Hendlin and Dr A L Demain), 1894
Absolute Scale of Time (Sir John Carroll), 260
Absorbancy Measurements on Liver and Kidney Cells (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Dr Bo Thorell and Prof Britton Chance), 934
Absorbancy Measurements on the *Neberkern* (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Dr Robert P Perry, Dr Bo Thorell, Dr Lennart Åkerman and Prof Britton Chance), 929
Absorption of Atmospheric Moisture by Freeze-dried Pork and Fish (Norman A Matheson), 1949
Absorption of Magnesium in the Large Intestine of the Calf (Dr R H Smith), 821
Absorption of Zinc Phosphide Particles (Dr A S Curry, Dr D E Price and Dr F G Tryhorn), 642
Absorption (Dieletric), in Dispersed Systems (G A Johnson and Dr S A Neale), 898
Absorption (Subcutaneous), of Urethane in Dehydrated and Fasted Mice (Eig Il Hvidberg and Jens Schou), 646
Absorption (Ultrasonic), in Acetic Acid at 450 kc /s by the Calorimetric Method (S Parthasarathy and V N Bindal), 631
Absorption (Ultra-violet), of Deoxyribo- or Ribo-Nucleic Acids Comparative Effects of Heat on Chromatography and (Dr Saul Kit), 36
Absorption (Vitamin B_{12}), in the Rat Effect of Ethylenediamine Tetraacetate on (Edward G Rice, Dr Samuel M Greenberg, John F Herndon and E J Van Loon) 1948
Absorption Bands (Infra-red) The Intensity of—a Bibliography (compiled by Dr R G Gillis), 682
Absorption Cells (Polyethylene), for Infra-Red Spectrophotometry (Trevor Robinson), 448
Absorption Maxima (Ultra-Violet), and the Electronegativity of the Adjacent Atoms in some Aliphatic Carbonyl Compounds A Correlation between the Shift in the (Dr P Borrell), 1932
Absorption Spectra (Visible), of Copper-ethylene-diamine-*bis* (acetylacetone) in the Crystalline State (Animesh Chakravorty and Dr Sadhan Basu) 50
Absorption Spectroscopy (Atomic) Determination of Magnesium in Blood Serum by (Dr J B Willis), 186
Absorption Spectrum of Flavin Adenine Dinucleotide Change of, by its Binding with both D-Amino Acid Oxidase Apo-Protein and Benzoate (Dr Kunio Yagi, Takayuki Ozawa and Minoru Harada), 1938
Absorption Spectrum (Red-Shift), of the Cygnus-*A* Radio Source (Dr R D Davies and Dr R C Jennison), 803
Abstract Algebra (Modern) Selections from (Richard V Andree), *review* by Prof T A A Broadbent, 301
Abyssal Priapulid *Priapulus abyssorum*, New Species, the first (Robert J Menzies), 1585
Acacia Pollen of, from Tufaceous Limestone near Udaipur (T Trivedi), 123
Acacia Species Occurrence of 4-Hydroxypipecolic Acid in (Dr J W Clark-Lewis and P I Mortimer), 1234
Academy of Sciences of the U S S R Publication in the Russian language of *High Molecular Compounds*, *The Geology of Ore Deposits*, *Palaeontological Journal*, *Radiochemistry*, *The Physics of the Solid Body*, *Cytology*, and *Soviet Slavic Studies*, 410
Academy of Sciences of the U S S R (Committee on Geodesy and Geophysics) Report on recent work in the Soviet Union in the field of Seismology, 322
Academy of Sciences of the U S S R (United States National Academy of Sciences and the) Exchange visits by research scientists of each country, 680
Acanthocottus lilljeborgi (Collett) in British Seas (P J Miller), 1162
Acari Mites or the (T E Hughes), *review* by G O Evans, 1677
Accelerator (Proton Linear), at the Rutherford High Energy Laboratory, 94
Accessory Pigments (Photosynthetically Active), of Cryptomonads (Photoreactive Pigments in Flagellates), (Dr F T Haxo and D C Fork), 1051
Accident at Windscale Accumulation of Radioactive Iodine in Thyroid Glands subsequent to Nuclear Weapon Tests and the (Dr Hamish A Robertson and Ian R Falconer), 1699
Accident (Nuclear Reactor *RB*), in Yugoslavia, 406
Accretion Coast Erosion and (British Association for the Advancement of Science, Sections E (Geography) and K (Botany), Discussion on), 499
Accumulation of Dextran in Human Red Cells after Haemolysis (N V B Marsden and S G Ostling), 723
Accumulation of Radioactive Iodine in Thyroid Glands subsequent to Nuclear Weapon Tests and the Accident at Windscale (Dr Hamish A Robertson and Ian R Falconer), 1699
Accurate Measurement An Image-Splitting Microscope for (J Dyson), 1561
Acer saccharinum L Formation of Allantoin and Allantoic Acid from Adenine in Leaves of (Robert N Barnes), 1944
Acetate (Cellulose) Cross-linking of, by Ionizing Radiation (Dr S H Pinner, T T Greenwood and D G Lloyd), 1303
Acetate (*p*-Nitrophenyl) Catalysed by Chymotrypsin Reactivity and Interrelationship of Intermediates in the Hydrolysis of (Mario A Marini and Prof George P Hess) 113
Acetate (Polyvinyl) Gas Chromatographic Separation of Long-chain Fatty Acid Methyl Esters on (Irwin Hornstein, L E Elliott and P F Crowe), 1710
    Separation of Polyvinyl Chloride and, by Chromatographic Methods (W J Langford and D J Vaughan), 116
Acetic Acid Ultrasonic Absorption in, at 450 kc /s by the Calorimetric Method (S Parthasarathy and V N Bindal), 631
Acetic Acid (Indole), and α-Naphthalene Acetic Acid Effect of, on the Growth, Flowering and Fruit Set in Sweet Potato (G Satyanarayana and Dr G Rangaswami), B A 73
Acetic Acid (3-Indole), in *Avena* Electrical Determination of Transport of (L A Newman), 1728
Acetic Acid (α-Naphthalene) Effect of Indole Acetic Acid and, on the Growth, Flowering and Fruit Set in Sweet Potato (G Satyanarayana and Dr G Rangaswami), B A 73
2-Acetoamido-2-Deoxy-α-D-Glucopyranoside (Methyl) *N*-Methylation of (Dr S A Barker, Prof M Stacey and Dr D J Tipper), 1718

INDEX

Acetone Combined Use of Polymyxin and, to obtain Cell-free Enzymes (J R Villaneuva), 1565
Acetone-Hydrochloric Acid Reaction of Formyl Porphyrins with (Dr P S Clezy), 1142
Acetophenetidin (Prof Paul K Smith), *review* by Dr Marthe Vogt, 1349
16-Acetyl Digitalinum Verum Chemistry and Pharmacology of (Z Kanda, Prof A Sekiya, K Katayama, A Okano and T Miki), 1414
Acetylase (Choline) Action of Ganglion Blocking Drugs on (Dr J E Gardiner), B A 71
Acetylcholine Effect of, on the Incorporation of Radiophosphorus into the Phosphatido-Peptide Fraction of Pancreas Slices (Prof C G Huggins), 1412
  Effect of Pempidine on the *in vitro* Synthesis of (Joan Parkinson), 554
  Reversal by, of the Inhibition by Thyroxine of Oxidative Phosphorylation in Guinea Pig Heart Sarcosomes (Heitor Medina and Metry Bacila), 1066
Acetylcholine and Eserine Effect of, on the Spawning of *Hydractinia echinata* (M Yoshida), 1151
Acetylcholinesterase (Blood), in *Phalaris* Staggers (Dr D J Walker), 1411
N-Acetylneuraminic Acid in *Escherichia coli* *N*,O-Diacetylneuraminic Acid in (Dr C W De Witt and J A Rowe), 381
Acheson, Fiona, and Fry, Dr R J M Induced Tolerance to D-Tubocurarine Chloride in the Cat, 1409
Achievements Some International Geophysical Year (Royal Society), 604
Acid Phosphatases (Pituitary), *in vitro* Effects of Methylthiouracil or Thyroidectomy on Activation of, by Whole Hypothalamic Extract (Dr V Schreiber and Dr V Kmentova), 728
Acid Strength of Propionate Side-Chains of Haematin Decrease in, on Reduction to Haem (Dr J E O'Hagan), 1808
Acid-fast Bacilli Difference between the Catalases of (Wieslaw Tysarowski and Stanislaw Kwiek), 1513
Acid-Schiff-Positive Material (Periodic), and Alkaline Phosphatase in the Uterine Wall of the Pig during the Sexual Cycle (Rolv Austad and Dr Otto Garm), 999
Acid-Secretion (Defensive), in some Marine Gastropods (Dr T E Thompson), 1162
Acid and Alkaline Phosphatase Visualization of, after Starch-Gel Electrophoresis of Seminal Plasma, Serum and Bile (Dr Bengt Estborn), 1636
Acidified Rat Serum Peptides with Oxytocic and Pressor Activity obtained from (Prof H Croxatto, T Pereda and R Mellada), 1496
Acids (Krebs Cycle) Oxidation of, by Apple Tissue (M D Hatch, J A Pearson, A Millerd and R N Robertson), 506
Acids (Organic) Two-Dimensional High-Voltage Paper Electrophoresis of Amino- and other (Dr D Gross), 1298
Acids (The Organic), in Rose Hips (Dr G A D Jackson and S E Y Barakat), 1953
Acids (Trans-Unsaturated), in the Depot Fat of Ruminants and Non-Ruminants (L Hartman and Dr F B Shorland), 2024
Acoustics International Congress on (Prof E G Richardson), 1031
Acoustique Musicale (Colloques Internationaux du Centre National de la Recherche Scientifique, No 84, Marseilles 1959), *review* by Prof E G Richardson, 1902
Acousto-Electric Effect Experiments on the (Piroska Smith (*née* Vermes) and D O Sproule), 264
Acquired Immunity The Clonal Selection Theory of (Sir Macfarlane Burnet), *review* by Dr J H Humphrey, 753
Acquired Resistance to Experimental 'Allergic' Encephalomyelitis Various Types of (G J Svet-Moldavsky, I A Svet-Moldavskaya and L I Raffkina), 1552
Acraniate Larvae Ecology of (J H Wickstead and Quentin Bone), 1849
Acres, G J K, and Dalton, F L A Capacitance Method for following Vinyl Polymerizations initiated by γ-Rays, 335
Acridine Dye Aggregation of an, on Native and Denatured Deoxyribonucleates (Dr D F Bradley and Dr G Felsenfeld), 1920
Actinomycin Synthesis Inhibition of, by D-Valine (Prof Edward Katz), 1666
Action Plant-Growth Substances and the Copper Chelating Theory of their (Dr C H Fawcett), 796
Action of Anhydrous Formic Acid on Peptides and Proteins (H Kienhuis, G Blasse and J Matze), 2015
Action of Ganglion Blocking Drugs on Choline Acetylase (Dr J E Gardiner), B A 71
Action of Inhibitor-β on the Growth of *Striga* Seedlings (C N Williams), 1577
Action of Manganese Dioxide on Simple Carbohydrates (Dr J L Bose, Dr A B Foster, Prof M Stacey and Dr J M Webber), 1301
Action of Mixed Solvents on Wool (J C Atkinson, A Filson and Prof J B Speakman), 444
Action of Ribonuclease on Nerve Axoplasm as Demonstrated by Silver Staining (R K Winkelmann and Robert W Schmit), 553
Action of Trypsin on α-Carbethoxy-L-lysyl-L-serylglycine and its O-Phosphorylated Analogue (Dr D Theodoropoulos, H Bennich, G Folsch and Prof O Mellander), 187
Action of Yeast on Glucose Changes in Adenosine Di- and Tri-phosphate Concentrations in the Early Stages of the (Dr J O Laws and Dr L H Stickland), 1246
Action (An Antimetabolic), of Vitamin K (Prof E Quagliariello, C Saccone, E Rinaldi and M R Alioto), 820
Action (An Antimineralocorticoid), of some Saluretic Sulphonamides (Dr G C Kennedy and Dr J D Crawford), 1492
Action (Atherogenic), of Excess Hydrocortisone Mechanism of the (Dr Henry Grossfeld), 38
Action (Biological), of Deoxyribonuclease I on the Growth of *Euglena gracilis* (Dr Rudolph K Zahn), 1324
Action (Biological), of Potassium-40 in Naturally Occurring Potash Salts (Prof E Welte and Kl Mechsner), 1958
Action (Growth-Controlling), of Human Serum in Cell Culture (Dr Kari Penttinen and Dr Erkki Saxen), 1570
Action (Hormone) Mechanism of (Prof Aaron B Lerner), 674
Action (Insecticidal), of Ethylene *Bis*dithiocarbamates (R D McMullen), 1338
Action (Joint), of Gibberellic Acid and Coumarin in Germination (A M Mayer), 826
Action (Nervous) The Discrete and the Diffuse in (James Arthur Lecture on the Evolution of the Human Brain), (Prof D P C Lloyd), 1777
Action (Neuromuscular Blocking), of some Antibiotics (G Bezzi and G L Gessa), 905
Action (Protective), of Interferon against Infection with West Nile Virus Duration of (Dr Alick Isaacs and Marguerite A Westwood), 1232
Action (Radiomimetic), of Lipoxidase (P Puig Muset, J Martin Esteve and J Valls Mateu), 1506
Action (Radioprotective), of Methoxamine (A D Smith, Dr M J Ashwood-Smith and Doreen Lowman), 1729
Action (Thiamine-sparing), of Sorbitol in Rats and Mice (Dr T B Morgan and Prof John Yudkin), 909
Action (Tryptic) O-Phosphorylated and Unphosphorylated Peptide-Substrates suitable for (D Theodoropoulos, H Bennich and Prof O Mellander), 270
Action Potentials from Single Nodes of Ranvier in Potassium-rich Solutions (Dr Hans-Christoph Luttgau), 1494
Action Potentials (Resting and), of Reversed Polarity in Frog Nerve Cells (Dr I Tasaki), 1574
Actions (Anti-Atherogenic and Endocrine) The C_{17}-OH Group of Œstradiol—Relationships between its (Dr Manuel Rene Malinow, Alvaro L Gimeno, Amanda A Pellegrino-Iraldi, Martha A Fernandez-Gimeno, Jorge L Lacuara and Jaime A Moguilevsky), 1720
Activated Charcoal Carbonization of Coals in the Presence of (Studies of Coal), (R L Bond, A M Goodridge, A R Murnaghan, D H Napier and D J Williams) 425
Activated Charcoal and Clays Insecticidal Effects of (S K Majumder, K S Narasimhan and V Subrahmanyan), 1165
Activation of Pituitary Acid Phosphatases *in vitro* by Whole Hypothalamic Extract Effects of Methylthiouracil or Thyroidectomy on (Dr V Schreiber and Dr V Kmentova), 728
Activation of Staphylococcal-free Coagulase by Purified Human Prothrombin (G Haughton and E S Duthie), 116
Activation Analyses of Six Trace Elements in Marine Biological Ashes Some (R Fukai and Prof W W Meinke), 815
Activation Analysis (Neutron) Determination of Chlorine in Muscle Tissues by (Dr Jonas Bergstrom), 1504
Activation and Inhibition of Adrenaline Metabolism (Dr Julius Axelrod and Dr Robert Tomchick), 2027
Activation and Inhibition of the Arylesterase of Human Serum (Prof E G Erdos, C R Debay and M P Westerman), 430
Active Fractions (Biologically), of Deoxyribonucleic Acid Immunization with, and Subsequent Specific Infection of Mice (Dr M Kohoutova), 1965
Active Principles of the Neurohypophysis of Cold-blooded Vertebrates—Chromatographic and Biological Characteristics of Fish and Frog Neurohypophysial Extracts (B T Pickering and Prof H Heller), 1463 , Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464 , Arginine Vasotocin (Panayotis G Katsoyannis and Prof Vincent du Vigneaud), 1465
Active Transport of Uric Acid through the Human Erythrocyte Membrane (Dr Kay Overgaard-Hansen and Dr Ulrik V Lassen), 553
Active (Photosynthetically) Accessory Pigments of Cryptomonads (Photoreactive Pigments in Flagellates), (Dr F T Haxo and D C Fork), 1051
Actively Fermenting Rumen of Sheep Relationship between *p*H and Volatile Fatty Acid and Diversion of Saliva from the (W R McManus), 1572
Activities (Chemical), of E *coli* adsorbed on a Resin, 'Dowex-1' (Tsutomu Hattori and Choseki Furusaka), 1566
Activities (Enzymic), of Human Skeletal Muscle Mitochondria—a Tool in Clinical Metabolic Research (Dr L Ernster, Dr D Ikkos and Dr R Luft), 1851
Activities (Intracellular), of Sodium and Potassium Glass Micro-Electrodes for Measuring (Dr J A M Hinke), 1257
Activities (Oxidative and Phosphorylative), of Cytoplasmic Particles from Plant Tissue Cultures (Taiki Tamaoki, Prof A C Hildebrandt, A J Riker, R H Burris and Bunji Hagihara), 1491
Activities (Plant Growth), of 5- and 8-Halogeno- Dihydro- and Tetrahydro-1-naphthoic Acids (Toshio Fujita, Sadao Imai, Koichi Koshimizu, Tetsuo Mitsui and Jiro Kato), 1415
Activity of Carbonic Anhydrase in Erythrocytes Influence of X-Rays on, and on their Haemolytic Resistance (A Lauwers, J Van Bavinchove and W Dierick) 111
Activity (Anticoagulant), of Human Arterial Mucopolysaccharides (Prof John E Kirk), 369
Activity (Anterior Pituitary-like), of Rumen Contents (Dr F A Soliman), 1723
Activity (Antileukaemic), of Polyporic Acid (J F Burton and B F Cain), 1326
Activity (Antiviral Chemotherapeutic), of Isatin β-thiosemicarbazone in Mice infected with Rabbit-pox Virus (D J Bauer and F W Sheffield), 1496
Activity (Cytochrome Oxidase), in the Sea Urchin Egg An Inhibitor of (Rachele Maggio and Alberto Monroy), 68
Activity (Diuretic) Sulphonamides with (Dr W Logemann, Dr P N Giraldi and Dr M A Parenti), 1711
Activity (Electrical), in the Muscle Cells of *Ascaris lumbrocoides* (Dr M Jarman), 1244
Activity (Geomagnetic), at Halley Bay on Disturbed Days (J MacDowall), 1543
Activity (High Ganglion-blocking) Congeners of Pempidine with (L Bretherick, G E Lee, E Lunt, W R Wragg and N D Edge), 1707
Activity (Increased Circulating Insulin-like), in Obese-Hyperglycaemic Mice (Jean Christophe, Yves Dagenais and Jean Mayer), 61
Activity (Lipase), in the Brown and Yellow Adipose Tissue of the Bat (Prof J C George and J Eapen), 59
Activity (Metabolic), of Deoxyribonucleic Acid in the Seminal Vesicle Influence of Sexual Stimulation on the (Dr S R Pelc), 1414
Activity (Nuclease), of Bean (*Phaseolus vulgaris*) Hypocotyls Influence of Kinetin β-Indoleacetic Acid and Gibberellic Acid on (Dr W Maciejewska-Potapczyk), 557
Activity (Optical), of Stercobilin and *d*-Urobilin (Prof C H Gray, P M Jones, Dr W Klyne and Dr D C Nicholson), 41
Activity (Oxidase), in the Mitochondria of the Human Heart Histochemical Localization of (Dr M S Burstone), 476

INDEX

Activity (Oxytocic and Pressor) Peptides with, obtained from Acidified Rat Serum (Prof H Croxatto, T Pereda and R Mellada), 1496
Activity (Paralysing), of *d*-Tubocurarine Chloride Increase by Chlorothiazide of the (Prof W Ferrari, G L Gessa and G Sangiorgi), 1235
Activity (Phagocytic), of the Macrophage System Assessment of the (Prof D L J Bilbey and Dr H Salem), 992
  Influence of Sulphur Dioxide Inhalation on the (Prof D L J Bilbey and Dr H Salem), 722
Activity (Phagocytic), of the Reticulo-Endothelial System Effect of Sulphonamides on the (Prof T Nicol and I A Sewell), 1241
Activity (Physiological), in Extracts of *Albizia* Species (A Lipton), 822
Activity (Plant-Growth Promoting) Isolation of Fatty Alcohols with, from Maryland Mammoth Tobacco (Dr A J Vlitos and Dr D G Crosby), 462
Activity (Positive Inotropic), of Cytidine Triphosphate (Winifred G Nayler and Marian McCulloch), 67
Activity (Secular Solar) Changes in the Climate of the Atlantic–European Area and (Z Gregor and L Křivsky), 682
Activity (Urinary β-Glucuronidase), in Patients with Bone Fractures (F J W Lewis and Dr Constance H J Plaice), 1249
Activity (Volcanic), on the Moon (N A Kozyrev), 856
Activity (Xanthine Oxidase) A Rapid and Sensitive Method for the Determination of, using the Oxygen Electrode (Metry Bacila and Dr Gilberto G Villela), 1394
Actomyosin-like Protein from Human Thrombocytes Extraction of an (M Bettex-Galland and Dr E F Luscher), 276
Acton Society Trust Creative Leadership in a State Service—a General Survey (Sir George Schuster), (Hospitals and the State—Hospital Organization and Administration under the National Health Service, Sixth and Final Research Report), 1087, 1201
Actual Distribution of the Number and Volume of the Islets of Langerhans in Different Size Classes in Non-diabetic Humans of Varying Ages (Bo Hellman), 1498
Acute Radiation Syndrome—a Medical Report on the Y-12 Accident, 1958 (compiled by Dr Marshall Brucer), (United States Atomic Energy Commission, Report ORINS-25), 1022
Acute and Chronic Morphine Administration Noradrenaline and Adrenaline in the Rat Brain during, and during Withdrawal (Dr Lars-M Gunne), 1950
Ada, G L, and others Failure to Recover Infective 'Ribonucleic Acid' from Myxovirus Preparations, 360
Adair, M E (Naylor, G R E, and) Serological Distinction of Adult and Foetal Human Haemoglobin, 1854
Adams, G K Rocket Propulsion (Thermodynamic Aspects of the Choice of Rocket Propellants), 1265
Adams, J B Biosynthesis of Chondroitin Sulphates, 274
  Appointed director of a new establishment to deal with controlled thermonuclear research, 595
Adams, L D Elected president of the Mathematical Association, 33
Adaptation of a Lead-tolerant Population of *Agrostis tenuis* to Low Soil Fertility (D Jowett), 43
Adaptation (Temporal), to Spatial Detail Vision Measurements of (A J Seyler and Z L Budrikis), 1215
Added Substances Effect of, on the Rate of Reductive Photo-bleaching (Reductive Photo-bleaching of Eosine), (Kengo Uchida, Shunji Kato and Masao Koizumi), 1620
Addingley, Dr C G, and Gaze, Dr R Measurement of Asbestos Dust Concentrations with the Long-Running Thermal Precipitator, 715
Addition of Aureomycin Effective Increase in Nematode Populations by the (C O R Everard and William A Feder), 1887
Additions to the British Museum (Natural History), (Sir Gavin de Beer), 1682
Adenine in Leaves of *Acer saccharinum* L Formation of Allantoin and Allantoic Acid from (Robert L Barnes), 1944
Adenine Dinucleotide (Flavin) Binding of the Sulphydryl Group in D-Amino-Acid Oxidase Apo-Protein with (Dr Kunio Yagi and Takayuki Ozawa), 1227
  Change of Absorption Spectrum of, by its Binding with both D-Amino Acid Oxidase Apo-Protein and Benzoate (Dr Kunio Yagi, Takayuki Ozawa and Minoru Harada), 1938
Adenosine Deaminases of Adenylic Acid and, in Rat Kidney (Dr M Zydowo), 1641
Adenosine Di- and Tri-phosphate Concentrations Changes in, in the Early Stages of the Action of Yeast on Glucose (Dr J O Laws and Dr L H Stickland), 1246
Adenosine Triphosphate Equilibrium Constant of the Galactokinase Reaction and Free Energy of Hydrolysis of (Dr M R Atkinson, Eleanor Johnson and Prof R K Morton), 1925
Adenosine Triphosphate and Serotonin Release of, from Injured Cellular Blood Elements in Extracorporeal Circuits (Dr H S S Sarajas, Dr R Kristoffersson and Dr M H Frick), 1127
Adenylic Acid and Adenosine Deaminases of, in Rat Kidney (Dr M Zydowo), 1641
Adhatoda vasica Nees A Bronchodilator Alkaloid (Vasicicone) from (A H Amin and D R Mehta), 1317
Adhesion (Ultrasonic Barium Titanate), and Paste Transducers (Dr A Lutsch), 1458
Adinolfi, M, and others Haemoglobin Pattern of the Cyclostome *Pertromyzon planeri* during the Course of Development, 1325
Adipose Tissue in Normal and Diabetic Rats Release of Non-Esterified Fatty Acids from (Dr J Wendeova and Dr J Pav), 1147
Adipose Tissue (Brown and Yellow), of the Bat Lipase Activity in the (Prof J C George and J Eapen), 59
Adler, H I Biological Effects of Low Doses of Ionizing Radiations (Observations with a variant of *Escherichia coli* which did not Synthesize Catalase), 1112
Adler, Prof S Darwin's Illness, 1102
Administered (Intravenously) Lactose Labelled with Carbon-14 Preliminary Observations on the Fate of (Dr Frederick J Carleton and Dr Henry R Roberts), 1650
Administration of Heavy Water Saliva-Serum Ratios of Deuterium Oxide after (Nan Taggart and Dr F E Hytten), 457
Administration of Tetracycline Inhibition of Skeletal Formation in the Chick Embryo following (Gerrit Bevelander, Hiroshi Nakahara and Gloria K Rolle), 728
Administration (Acute and Chronic Morphine) Noradrenaline and Adrenaline in the Rat Brain during, and during Withdrawal (Dr Lars-M Gunne) 1950
Administration (British) The Spirit of, and some European Comparisons (C H Sisson), 128
Administration (Intravenous), to Rats Presence of certain Onium Compounds in Brain Tissue following (Prof Ruth R Levine), 1412
Administration (Prolonged Thyroid) Effect of, on Male Aged Rats (Prof John F Lhotka, Lloyd Glenn McArthur and Arthur A Hellbaum), 1149
Administration and Law The Economics of Nuclear Power, including (edited by I R Maxwell, P W Mummery and Philip Sporn), Vol 2, *review* by R Brightman, 1673
Administrative Problems in Expanding Universities (Home Universities Conference, 1959), 1613
Admiralty Grant of £9,534 10s to the University of Oxford, for the continuation of research on centimetre waves and fundamental problems, 1273
Adonis annua L Occurrence of Astaxanthin in the Flower Petals of (A Seybold and Prof T W Goodwin), 1714
Adrenal Catechol Amines induced by Reserpine Abolition by Chlorpromazine of the Inhibiting Effect of Iproniazid on the Depletion of (F Camanni, Dr G M Molinatti and M Olivetti), B A 65
Adrenal Extracts 3,4,ω-Trihydroxyacetophenone 3-methyl Ether in (J von Euw, Prof T Reichstein, R Neher, Dr A Wettstein, Dr J F Tait and Dr S A S Tait), 268
Adrenal Lipids (Rat) Use of Porter–Silber and Schiff Reactions as Spot Tests for Steroids applied on Paper and their Application to the Study of (Dr Marion K Birmingham), B A 67
Adrenal Medulla (Denervated) Effects of Reserpine on Secretion from the (L Stjarne and S Schapiro), 2023
Adrenal Medullary Secretion of Catechol Amines Effects of 1,4-Dihydra zinophthalazine on Organ Content and (M Bydgeman and L Stjärne), 1646
Adrenalectomized Mice (Normal and) Effect of Diet on the Blood Sugar and Liver Glycogen Level of (B P Block and Dr G S Cox), 721
Adrenalectomized Rats Sodium Chloride Intake and Urinary Histamine in (Dr T Bjuro and Dr H Westling), 1241
Adrenalectomy Effect of, on the Hormone Content of the Thymus in the Rat (Dr J Comsa), 279
Adrenaline Formation of Noradrenaline from, by Rat Liver Mitochondria (Dr Kunio Yagi and Dr Toshiharu Nagatsu), 1316
Adrenaline in the Rat Brain during Acute and Chronic Morphine Adminstration and during Withdrawal Noradrenaline and (Dr Lars-M Gunne), 1950
Adrenaline Metabolism Activation and Inhibition of (Dr Julius Axelrod and Dr Robert Tomchick), 2027
Adrenaline and Noradrenaline Response of Cholinergically Innervated Sweat Glands to (Dr David P C Lloyd), 277
Adrenocortical Steroids Biosynthesis and Secretion of (Biochemical Society Symposium on), 415
Adrenocorticosteroids *in vitro* Failure of Corpuscles of Stannius from Winter Flounder (*Pseudopleuronectes americanus*) to Synthesize (Dr J G Phillips and Dr P J Mulrow), 558
Adsorption Isotherm (Langmuir) Kinetic Study of Dextransucrase based on the (W Brock Neely and C F Thompson), B A 64
Adult Chicken Blood Cytological Identification of Proliferating Donor Cells in Chick Embryos injected with (P M Biggs and L N Payne), 1594
Adult *Drosophila* Synthesis of Deoxyribonucleic Acid in (Per Oftedal), 1961
Adult Education, National Institute of After Work—Leisure and Learning in Two Towns (R Ruddock and Dr A Wilson), 1034
Adult Education, Universities Council for Report for 1957-1958, 331
Adult Houseflies Mechanisms of Resistance of, to the Insecticide Dieldrin (F P W Winteringham and A Harrison), 608
Adult Lymphoid Tissues Influence of, on Polyoma-induced Tumours (Dr V Defendi and Dr H Koprowski), 1579
Adult Mice Tolerance to Skin Homografts of, after Parabiosis (Dr B A Rubin), 205
Adult Noctuidae (Lepidoptera) in Cambodia Blood-feeding Habits of (W Buttiker), 1167
Adult Sheep (Foetal and) Inositol Concentration in the Cerebrospinal and Ocular Fluids and Tissues of the (D A Nixon), 906
Adult and Foetal Human Haemoglobin Serological Distinction of (G R E Naylor and M E Adair), 1854
Advanced Analytical Chemistry (Prof Louis Meites and Prof Henry C Thomas), *review* by W I Stephen, 1525
Advanced Gas-cooled Reactors (United States Atomic Energy Commission and the United Kingdom Atomic Energy Authority to exchange Technical Information on), 1361
Advancements in Metallurgy, *review* by Dr F C Thompson, 1765
Advances in Biological and Medical Physics, Vol 6 (edited by Cornelius A Tobias and John H Lawrence), *review* by Dr N M Blackett, 1766
Advances in Carbohydrate Chemistry (edited by Melville L Wolfrom in association with R Stuart Tipson), Vol 13, review by Dr Alfred Gottschalk, 662
Advances in Catalysis and related Subjects, Vol 9 (edited by Adalbert Farkas), *review* by Dr E B Maxted, 750, Vol 10 (edited by D D Eley, W G Frankenburg and V I Komarewsky), *review* by Dr F S Stone, 1974
Advances in Electronics and Electron Physics (edited by L Marton, assisted by Claire Marton), Vol 10, *review* by J R Tillmann, 1601
Advances in Inorganic Chemistry and Radiochemistry (edited by H J Emeleus and A G Sharpe), Vol 1, *review* by Dr D W A Sharp, 1756
Advances in Pest Control Research (edited by R L Metcalfe), Vol 2, *review* by F C Bawden, 1258
Advances in Semi-Conductor Science—Proceedings of the Third International Conference on Semi-Conductors, Rochester 1958 (edited by H Brooks), *review* by Dr J R Tillman, 1674
Advances in Virus Research (edited by Kenneth M Smith and Max A Lauffer), Vol 6, *review* by N W Pirie, 920
Advisory Committee on the Inland Telegraph Service Report of the, 1191
Advisory Council, National Joint Report of an inquiry into the Efficient Use of Man-power in Industry (Ministry of Labour and National Service), 25

Advisory Council on Scientific Policy Annual Report for 1958-1959, 1897
Advisory Council on Scientific Policy (Committee on Scientific Man-power) Report on Scientific and Engineering Man-power in Great Britain (1959), 1982
Advisory Council on Scientific Policy of the Union of South Africa First and Second Annual Reports, 1191
Advisory Council for Technological Education (London and Home Counties Regional) Tenth Annual Report, 94
Advisory Group for Aeronautical Research and Development (Combustion and Propulsion Panel) Discussion on the Chemistry of Propellants, 778
Discussion on Basic Problems in Propulsion, 779
Advisory Water Committee, Central First Report of the Subcommittee on the Growing Demand for Water, B A 18
Report of the Subcommittee on Information on Water Resources, B A 18
Re-appointments and new appointments 153
Aedes Mosquitoes Control of Hatching in the Prediapause Eggs of (Dr J D Gillett), 1621
Aedes aegypti (L) Probing Behaviour of, in Response to Heat and Moisture (L Burgess), 1968
A E I -Birlec, Ltd Name of Birlec, Ltd , to be changed to, 1535
Aerial Photographs of Quarries and Mines Exhibition of (Geological Museum), 855
Aerobic Corrosion Fatigue Life of Steel Relationship of *p*H to (Dr Frederick J Radd, L Hugh Crowder and Louis H Wolfe), 2008
Aerobic Oxidation of D-Xylose Glycolaldehyde Trapped from, by *Torulopsis utilis* (V Bolcato and G Leggiero), 1318
Aerobiosis and Anaerobiosis Fluorescence Measurements of Mitochondrial Pyridine Nucleotide in (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Prof Britton Chance and Dr Bo Thorell), 931
Aeronautical Research and Development, Advisory Group for (Combustion and Propulsion Panel) Discussion on the Chemistry of Propellants, 778
Discussion on Basic Problems in Propulsion, 779
Aeronautical Society, Royal Formation of an Agricultural Aviation Group, 25
Discussion on the Structural Effects of Kinetic Heating, 30
Prize of £5,000 offered by Henry Kremer for the first successful flight of a Man-powered Aircraft, 1534
Aeronomy Chemical—Proceedings of the Conference on (sponsored by the Geophysics Research Directorate, Air Force Cambridge Research Center, Cambridge, Mass , 1956), (edited by M Zelikoff), *review*, 1011
Aerosols Pressurized Packaging—(A Herzka and J Pickthall), *review* by Dr V G W Harrison, 1437
Aerva tomentosa Forsk *In vitro* Culture of the Inflorescences, Flowers and Ovaries of an Apomict (Prem Murgai), 72
Afferents (Vagal), in the Monkey (Prof Kent M Chapman and Prof James W Pearce), 1237
Affinites Chromosomiqes dans le Genre Coffea Recherchés sur les (J Bouharmont), 518
Affinity of Lysozyme to Structural Elements of the Bacterial Cell as studied with Enzyne Labelled with Radioactive Iodine (Prof C Weibull, B Zacharias and H Beckman), 1744
Africa Vegetation Map of (Explanatory notes by R W J Keay, with a French translation by A Aubreville), 594
Africa (East) Higher Education in (White Paper on), 243
Report of the Working Party on Higher Education in (1958), 243
Higher Education in (Work on the new Technical Institute), 1611
Looking for Animals in (E H Tong), 1535
Sea Fisheries Research in, 855
Africa (South), Advisory Council on Scientific Policy of the Union of First and Second Annual Reports, 1191
Africa (Southern) Eels in (R A Jubb), 827
Africa (Tropical) The Insect Pests of Cotton in (E O Pearson, assisted by R C Maxwell Darling), *review* by Dr W E China, 1011
Africa (Tropical East) Flora of——Leguminosae sub-family Mimosoideae (J P M Brenan), 409
Africa (West) *Capsicum* Species of (C Oyolu), 1163
African Botany, 594
African (British East) Waters Black Marlin in (F Williams), B A 78
African (Central) Scientific Research, 407
African (East) Marine Fisheries Research Organization Annual Report for 1958, 855
African (South) Animal Life—Results of the Lund University Expedition in 1950-51, Vol 5 (edited by Bertil Hanstrom, Per Brinck and Gustaf Rudebeck), *review*, 133
African (South) Council for Scientific and Industrial Research Thirteenth Annual Report (1957-58), 1449
African (South) Peoples Haptoglobin and Transferrin Variants in Bushmen and some other (Dr N A Barnicot, J P Garlick, Ronald Singer and Dr J S Weiner), 2042
After Work—Leisure and Learning in Two Towns (R Ruddock and Dr A Wilson), 1034
After-Effect (Fatigue-Induced), in Zinc Single Crystals (A H Meleka and G B Dunn), 896
Agar (Simmons's Citrate) Production of Colicines in (Dr J Paravassiliou), 1339
Agar Diffusion Estimation of Vitamin C by (Alan H Chaiet and Louis Chaiet), 1487
Agar Electrophoresis of Normal Soluble Proteins in Guinea Pig Liver (Prof Iv Goranov, Y Todorov, X Skatshokova, M Hlebarova and P Kuzmanova), B A 64
Agar Gel Direct Spectroscopic Examination of Electrophoretic Zones in (Dr G H Beaven and W B Gratzer), 359
Agar Substrates Maintenance of Parathyroid Tissue Fragments on (Dr John H Wallace, Dr George J Hill, Jean M McCarthy and Dr John R Brooks), 1734
Agar and Soil Cultures Translocation of Cobalt-60 and Caesium-137 by Fungi in (Dr Erna Grossbard and Dr D R Stranks), 310
Age of *Carcharodon megalodon?* (W Tschernezky), 1331
Age of Science Education for the (Report of the Science Advisory Committee to the President of the United States), 81, 87
Liberty in an (Sir Solly Zuckerman,) 135
Age of the Stars Structure and (C B Haselgrove and F Hoyle), 1986
Age and the Working Lives of Men (F Le Gros Clark), 318
Age' ('Cosmic Ray), for the Iron Meteorite 'Carbo' Calculation of a (Dr Royal R Marshall), 117
Age (Old) Mental Health Problems in (World Health Organization of the United Nations, Technical Report Series No 171), 1844
Age Determination in *Mansonioides* Mosquitoes (R H Wharton), 830
Age Determination in Wild Rabbits (R H Taylor), 1158
Aged Rats (Male) Effect of Prolonged Thyroid Administration on (Prof John F Lhotka, Lloyd Glenn McArthur and Arthur A Hellbaum), 1149
Ageing A Theory of (J Maynard Smith), 956 , (Prof Leo Szilard), 957
Ageing of Plastics International Symposium on the (Eighth German Plastics Convention,) 508
Ageing (X-Ray Induced) Latent Period of—a Study based on Mortality Rate and Tumour Incidence (Dr H I Kohn and Dr P H Guttman), 735
Ageing Worker The 318
Agent (Pathogenic), of Tyzzer's Disease of Mice Pure Culture of the (Dr K Kanazawa and A Imai), 1810
Agents (Anti-Staling) Interaction of, with Starch (Prof E J Bourne, A I Tiffin and Dr H Weigel), 547
Ager, Dr J A M The Heterogeneity of Human Haemoglobin, *review*, 840
Ager, Dr J A M , and others Detection of Thyroid Antibodies using Bentonite Particles, 478
Ages (Different) Enzymes and Radioactivity in Erythrocytes of (Dr Lester M Levy, Harry Walter and Martin D Sass), 643
Ages (Rubidium-Strontium), of Lewisian Rocks from North-West Scotland (Dr Bruno J Giletti), 1793
Ages (Varying) Actual Distribution of the Number and Volume of the Islets of Langerhans in Different Size Classes in Non-diabetic Humans of (Bo Hellman), 1498
Agglutinating Auto-Antibody (Panagglutinin) Production of an, Active upon Tanned Erythrocytes in the Rabbit (P O Hubinont, P Ghysdael and O Thys), 1250
Agglutinating Sera and the Corresponding Red Blood Cell Receptors Influence of Streptomycin Solutions on the Interaction between the (Dr M Kout and Dr Z Kubickova), 639
Agglutinins in Lymphomatous Mouse Tissue Partial Identification of Lysins and (Dr Eric Ponder and Ruth V Ponder), 819
Aggregation of an Acridine Dye on Native and Denatured Deoxyribonucleates (Dr D F Bradley and Dr G Felsenfeld), 1920
Aglycone (Cardiac) Microbiological Transformation of a (Hayao Nawa, Masao Uchibayashi, Takaaki Kamiya, Togo Yamano, Hideo Arai and Matazo Abe), 469
Agricultural Advantage The Land of Britain—is it Used to the Best (Association of Agriculture and the Extra-Mural Department of the University of London Lectures on), 1845
Agricultural Aviation Group formed by the Royal Aeronautical Society, 25
Agricultural Botany at Bangor, 502
Agricultural Botany at Leeds, 405
Agricultural Botany, National Institute of Leaflets on Fodder Beet, Mangels and Swedes, 1777
Agricultural Bureaux, Commonwealth Appointment of A Perera as chairman of the Executive Council, 943
Agricultural Chemistry in Aberystwyth, 317
Agricultural History Society, British Winter Conference (G E Fussell), 1916
Agricultural Institute of Ireland (An Foras Taluntais), Dublin, 28
Appointment of Dr T Walsh as director, 29
Appointment of Dr L B O'Moore as chief of the Animal Production Division, 29
Appointment of J J Byrne as chief of the Rural Economy Division, 29
Award of junior postgraduate agricultural research scholarships, 1612
Division of Plant Sciences and Crop Husbandry, 1847
Agricultural Research The Use of Radioisotopes in (Ministry of Food and Agriculture of the Government of India, Food and Agriculture Organization of the United Nations, International Atomic Energy Agency and Unesco South East Asia Science Co-operation Office Course on), 1451
Agricultural Research in Britain, 238
Agricultural Research in Eire—An Foras Taluntais (The Agricultural Institute), 28
Appointment of Dr T Walsh as director, 29
Appointment of Dr L B O'Moore as chief of the Animal Production Division, 29
Appointment of J J Byrne as chief of the Rural Economy Division, 29
Award of junior postgraduate agricultural research scholarships, 1612
Division of Plant Sciences and Crop Husbandry, 1847
Agricultural Research, Indian Council of Misc Bulletin No 82, Bovine Stars of India, 941
Agricultural Research, Indian Council of, and Unesco International Symposium on Algology, 595
Agricultural Research Council Memoirs of the Soil Survey of Great Britain—England and Wales , The County of Anglesey—Soils and Agriculture (E Roberts), 154
Report for 1957-58, 238
Appointment of Lord Netherthorpe and Prof F W Rogers Brambell as members, 508
Special Promotions, 859
Grant of £1,893 to the University of Leeds, for two research projects in the Department of Agriculture , and £2,807 for research into the interpretation of fibre types in sheep, in the Department of Anatomy, 1108
Strontium-90 in Human Diet in the United Kingdom, 1111
Appointment of Prof E G Cox as secretary, 1688
Agricultural Research Council, the Medical Research Council and the Development Commission on Biological (Non-Medical) Problems of Nuclear Physics Appointment of Sir James Denby Roberts as chairman of the Joint Committee of the, 237
Agricultural Research Scholarships Junior Postgraduate (Agricultural Institute of Ireland Awards), 1612
Agricultural Research Station (Central), Carapichaima, Trinidad (Dr A J Vlitos), 331

- Agricultural Science Sixth Easter School in, at the University of Nottingham School of Agriculture (The Measurement of Grassland Productivity), 154
- Agricultural Society of England, Royal Medal for research work of benefit to Agriculture, 1450
- Agricultural Variety Trials Influence of Site and Season on (A Sandison), 834
- Agricultural and Horticultural Crops The Control of Pests and Diseases in (G L Hey and K Marshall), *review* by F C Bawden, 1258
- Agriculture Medal for research work of benefit to (Royal Agricultural Society of England), 1450
  - Nature and (Dr E B Worthington), 1535
- Agriculture, Association of, and the Extra-Mural Department of the University of London Lectures on the Land of Britain—is it Used to the Best Agricultural Advantage?, 1845
- Agriculture, Fisheries and Food, Ministry of Appointment of Dr H R Barnell as chief scientific adviser (food), 503
  - Technical Bulletin No 7, Plant Nematology, 855
  - Infestation Control, a Service to Agriculture and Food Storage, 941
- Agriculture and Food Storage Infestation Control, a Service to (Ministry of Agriculture, Fisheries and Food), 941
- *Agrostis tenuis* Adaptation of a Lead-tolerant Population of, to Low Soil Fertility (D Jowett) 43
- Ahmed, Z F, and others *In vitro* Study of the Anthelminthic Property of *Artemesia monosperma* grown in Egypt, 647
- Ahmedabad Textile Industry's Research Association, 160
  - Proceedings of the Fifth Management Conference (1959), 1913
- Ahronheim, Dr J H (Reed, Dr T Edward, and) An Association between Abo Blood Groups and Fertility in a Normal American Population, 611
- Ahuja, Dr M L, and others Statement on Biological and Chemical Warfare, 1018
- Aid of a Continually Renewable Filter A Partial Chemical Characterization of Maize Coleoptile Cell Walls prepared with the (Prof Aleksander Kivilaan, Teofila C Beaman and Robert S Bandurski), B A 81
- Aid in the Study of Fungal Spore Morphology '*LO*-Analysis' as an (Dr M M Payak), 738
- Aid (British), for NATO Scientific Courses, 406
- Aigrain, Prof P, and others (edited by) Progress in Semiconductors, Vol 3, *review* by Dr R A Hyman, 1754
- Aiken, Prof Howard H Awarded the Vermeil Medal of the City of Paris, B A 16
- Ainger, F W, and Herbert, I M Special Ceramics (Preparation of Phosphorus-Nitrogen Compounds as Non-porous Solids), 1116
- Air Condensation Processes for the Extraction of Radioactivity from (Rama), 1789
  - Habit of Ice Crystals grown in Hydrogen, Carbon Dioxide and, at Reduced Pressure (A P van den Heuvel and Dr B J Mason), 519
- Air and in Water Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in, for Occupational Exposure (United States National Bureau of Standards, Handbook 69), 939
- Air Density in the Upper Atmosphere from Satellite Orbit Observations (Dr G V Groves), 178
- Air Force Cambridge Research Center (United States) Conference on Silicon Carbide, 158
- Air Force Cambridge Research Center (United States), (Electronics Research Directorate) Conference on Extremely High Temperatures, Boston, 1958 (edited by Dr Heinz Fischer and Lawrence C Mansur), *review* by Dr T E Allibone, 83
- Air Force Cambridge Research Center (United States), (sponsored by the Geophysics Research Directorate of the) The Threshold of Space—Proceedings of the Conference on Chemical Aeronomy, Cambridge, Mass, 1956 (edited by M Zelikoff, *review*, 1011
- Air Force Office of Scientific Research (United States) First Annual Astronautics Symposium—Vistas in Astronautics (edited by Morton Alperin and Marvin Stern), *review* by D G King-Hele, 663
- Air Ministry (Meteorological Office) Geophysical Memoirs No 100, World Distribution of Atmospheric Water Vapour Pressure (G A Tunnell), B A 15
- Air Pump (Boyle's) Robert Hooke and (Dr H D Turner), 395
- Air Surveys and the Social Scientist (Leo Silberman), 244
- Air-borne Nitrogenous Material and other Plant Nutrients Surface of the Ocean as a Source of (Dr A T Wilson), 99
- Aircraft Establishment, Royal Appointment of Prof M J Lighthill as director, 151
  - Promotion of P A Hufton to Chief Scientific Officer and appointment as head of the Aerodynamics Department, 233
- Aircraft (Man-powered) Prize of £5,000 offered by Henry Kremer for the first successful flight of a, 1534
- Aircraft Noise (Jet) Effect of, on Hearing (Surg Lieut R R A Coles and J J Knight), 1803
- Aitken, Dr R S Hundred Years of the University of Calcutta, *review*, 218
- Aitken W G, and others Summary of the Geology of Tanganyika, Part I, Introduction and Stratigraphy, 1688
- Aiyar, A S, and others Pantothenic Acid Deficiency and Ubiquinone Levels in Rat Liver Mitochondria, 1867
- Åkerman, Dr Lennart, and others Localization and Assay of Respiratory Enzymes in Single Living Cells—Absorbancy Measurements on the *Neberkern*, 929
- Åkerstrom, Stig (Vänngard, Tore, and) Electron Spin Resonance and Divalency of some Dithiocarbamates of the Coinage Metals (Cu, Ag, Au), 183
- Akimov, I, and others Energy Transfer with special reference to Biological Systems (Properties of Isolated Chlorophyll), 690
- Alaska Micropulsation Measurements in California and (W H Campbell and B Nebel), 628
- Albemarle, Countess of Science by the Upper Form, 597
- Albert, Prof Adrien Heterocyclic Chemistry, *review* by Dr F G Mann, 216
- Albert, Prof Adrien, and Nasasen, Prof Reino Stability of Metal Complexes of Oxine and its Sulphonic Acid, 449
- Alberta Scientific Research in, 1370
- Åbertsson, Per-Ake, and Nyns, Ed Jacques Counter-Current Distribution of Proteins in Aqueous Polymer Phase Systems, 1465, *erratum*, 1688
- Alberty, R A, and Hammos, G G Fast Chemical Reactions in Solution (Application of the Relaxation Method to Enzymatic Reactions), 1453
- Albinism in Coconut Seedlings (Dr K M Pandalai and R V Pillai), 1163
- Albino (Semi-), a Third Sex-linked Allelomorph of Silver and Gold in the Fowl (W F Werret, A J Candy, J O L King and Dr P M Sheppard), 480
- *Albizia* Species Physiological Activity in Extracts of (A Lipton), 822
- Albrecht, F O, and others Maternal Control of Ovariole Number in the Progeny of the Migratory Locust, 103
- Albumin (Serum) Production of, and of Globulins by Chick Mesenchymal Tissue and by HeLa Tumour Tissue in Culture (Y Abdel-Samie, Prof E Broda, G Kellner and W Zischka), 361, *erratum*, 943
- Alcock, Dr C B (Grieveson, P, and) Special Ceramics (Measurements of the Dissociation Pressures of Metallic Silicides and of Silicon Carbide), 1116
- Alcohol (Ethyl) Oxidation of, by a Mixture of Hydrogen Peroxide and Ferric Salts (Dr Mordechai L Kremer), 720
- Alcohols (Fatty), with Plant-Growth Promoting Activity Isolation of, from Maryland Mammoth Tobacco (Dr A J Vlitos and Dr D G Crosby), 462
- Alcorn, J W S, and others Gibberellic Acid and Nodulation of Legumes, 1576
- Alderson, J E A At the Second Australian Spectroscopy Conference (Luminescence Spectra of Thallium-doped Potassium Iodide), 1196
- Aldred, A T Appointed Research Fellow in physical metallurgy in the University of Birmingham, 684
- Alekna, V P, and others α-Radioactivity of Cerium-142, 630
- Alekseev, Dr A P, *et al* Polar Front Survey (Hydrography—Russian work in the southern part of the Norwegian Sea), 1181
- Alexander, Dr P Biological Effects of Low Doses of Ionizing Radiations (Physico-chemical Studies on Effects of Radiation on Deoxyribonucleic Acid *in vitro* and in Herring Sperm), 1112
- Alexander, Dr P, and Stacey, Dr K A Cross-Linking of Deoxyribonucleic Acid in Sperm Heads by Ionizing Radiations, 958
- Alexander, Dr P, and others Disorganization of the Secondary Structure in Proteins exposed to Ionizing Radiations in the Solid State, 226
- Alga (Marine Red) A Free-Floating (Dr H B S Womersley and Dr R E Norris), 828
- Algae and other Micro-organisms Culture of, in Deuterium Oxide (Henry L Crespi, Sylvia M Archer and Joseph J Katz), 729
- Algae (Green) Chloroplast Pigments of Deuterated (Harold H Strain, Henry L Crespi and Joseph J Katz), 730
- Algal Cells Value of a Simple Observational Technique for Determining the Fat Content of (Dr J H Evans), 1737
- Algebra (Matrix), in Structural Analysis, *review* by R K Livesley, 1600
- Algebra (Modern Abstract) Selections from (Richard V Andree), *review* by Prof T A A Broadbent, 301
- Algesimetry Aspirin and (Dr C V Winder), 494
- Algology International Symposium on (Indian Council of Agricultural Research and Unesco), 595
- Ali, Dr, M A and Hoar, Prof W S Retinal Responses of Pink Salmon associated with its Downstream Migration, 106
- Alibag Observatories, Colaba and Retirement of S L Malurkar from the directorship 1611
- Alimentary Tract (Mammalian) Glycosidases in the (J Conchie and D C Macdonald), 1233
- Alioto, M R, and others An Antimetabolic Action of Vitamin K, 820
- Aliphatic Amines and related Compounds High-Voltage Paper Electrophoresis of (Dr D Gross), 1633
- Aliphatic Carbonyl Compounds A Correlation between the Shift in the Ultra-Violet Absorption Maxima and the Electronegativity of the Adjacent Atoms in some (Dr P Borrell), 1932
- Alkali, etc, Works in England and Wales Ninety-fifth Report (1958) of the Chief Inspector on, 940
- Alkali Ion Determinations by means of Glass Electrodes (Research Symposium at the University of Sheffield), 1616
- Alkaline Phosphatase Periodic Acid-Schiff-Positive Material and, in the Uterine Wall of the Pig during the Sexual Cycle (Rolv Austad and Dr Otto Garm), 999
- Alkaline Phosphatase (Acid and) Visualization of, after Starch-Gel Electrophoresis of Seminal Plasma, Serum and Bile (Dr Bengt Estborn), 1636
- Alkaline-denaturation Properties A Haemoglobin with Unusual, in a Turkish-Cypriot Woman (Dr J E O'N Gillespie, Dr J C White, M J Ellis, Dr G H Beaven, W B Gratzer, Dr E M Shooter and R M E Parkhouse), 1876
- Alkaloid (A Bronchodilator), Vasicicone, from *Adnatoda vasica* Nees (A H Amin and D R Mehta), 1317
- Alkaloids The (K W Bentley), (The Chemistry of Natural Products, Vol I), *review* by Prof A J Birch, 754
- Alkaloids (Berberine), via 6,7-Dimethoxy*iso*quinoline-1-aldoxime (Dr C K Bradsher and Dr N L Datta), 1943
- Allan, D W Ionization Phenomena in Gases (Detailed Behaviour of the Simple Unstabilized Pinch in respect of the Inward Movement of the Current Sheet), 1357
- Allan, Frederick J, and others Mothicidal Rhodanine Derivatives, 1637
- Allan, G Graham, and others Mothicidal Rhodanine Derivatives, 1637
- Allan, Joyce (Whitley, Gilbert, and) The Sea-Horse and its Relatives, *review* by T H Hawkins, 390
- Allan, J E At the Second Australian Spectroscopy Conference (Analysis of Magnesium by Atomic Absorption), 1197
- Allanson, J T Modern Network Theory in Electrical Engineering, 1691
  - Modern Network Theory in Electrical Engineering (Synthesis of Three-Terminal Resistance-Capacitance Networks), 1692
- Allanson, J T (Bell, Dr D A, and) Appointed joint acting heads of the Department of Electrical Engineering in the University of Birmingham, 1688
- Allantoic Acid from Adenine in Leaves of *Acer saccharinum* L Formation of Allantoin and (Robert L Barnes), 1944
- Allantoin and Allantoic Acid from Adenine in Leaves of *Acer saccharinum* L Formation of (Robert L Barnes), 1944
- Alleles (β-Globulin) in some Zebu Cattle (G C Ashton), 1135
- Alleles (Iso-) Effect of Different Wild-Type, on Crossing-over in *Drosophila melanogaster* (M M Green), 294

Allelomorph (Sex-linked), of Silver and Gold in the Fowl Semi-Albino, a Third (W F Werret, A J Candy, J O L King and Dr P M Sheppard), 480
Allen, C F H, in collaboration with G M Badger, Brice Graham, G A Reynolds, James H Richmond, John R Thirtle, J A Van Allen and C V Wilson Six-Membered Heterocyclic Nitrogen Compounds with Three Condensed Rings, *review* by Dr F G Mann, 216
Allen, Sir George (Swinton, Dr W E, and) To represent the British Association for the Advancement of Science in a visit to the U S S R, 1271
Allen, Dr J A Future Marine Biological Research, *review* 215
Allen, J E, and Magistrelli, F Ionization Phenomena in Gases (Experiments on the Plasma Sheath Transition in the presence of a Magnetic Field), 1357
Allen, Prof J F The Very Cold World, *review*, 1260
Allen, K A, and others Unidentified Growth Factors, 271
Allen, Dr K W Thermonuclear Processes (Order of Magnitude Difference in the Relevant Charge Exchange Cross-sections), 241
  Thermonuclear Research, 1015
Allen, Dr K W, and Julian, F A, and others The Tandem Generators of the United Kingdom Atomic Energy Authority, 303
Allen, M Role of the Anion in Magnesium Uptake from Foliar Applications of its Salts on Apple, 995
Allen, Dr Mary Belle, and others Photo-reactive Pigments in Flagellates—Chromoprotein Pigments of some Cryptomonad Flagellates, 1047
Allen, Dr M Delia Bumblebees, *review*, 1178
Allen, N P, and Edmondson, B Atomic Mechanisms of Fracture (Necking down of Single Crystals of Iron), 325
Allen, Dr Roy M Photomicrography, second edition, *review* by Dr S Bradbury, 1174
Allen, W D, and Pyrah, A E, and others The Tandem Generators of the United Kingdom Atomic Energy Authority, 303
'Allergic' Encephalomyelitis (Experimental) Various Types of Acquired Resistance to (G J Svet-Moldavsky, I A Svet-Moldavskaya and L I Raffkina), 1552
Allergy (Egg-White), in the Rat Influence of the Thymus upon the (J Comsa), 1726
Allibone, Dr T E Extremely High Temperatures, *review*, 83
  Merlin, an Industrial Research Reactor, B A 11
  The Release and Use of Atomic Energy (Christmas Lectures at the Royal Institution), 1613
Allison, Dr J Appointed a lecturer in electrical engineering at the University of Sheffield, 684
Allison, Prof P R Flow Properties of Biological Systems (Increasing Importance of Rheology in Medicine and Surgery), 1539
Allium cepa and *Calliphora vomitoria* Electron Spin Resonance Investigations of (M Edwards, Dr G A Kerkut, K A Munday, Dr D J Ingram, M C Saxena and L Leach), 1402
Allnut, A J Fluctuation Phenomena and Stochastic Processes (Effect of Persistence on a Random Walk), 510
Allomyces (Water Fungi *Blastocladiella* and) *Gamma* Particles, Nadi-Positive Mitochondria, and Development in the (Prof Edward C Cantino and Gilbert Turian), 1889
Alloxan Inhibition of Liver Hexokinase by Dehydroascorbic Acid and (Dr S K Bhattacharya), 1638
Alloxan and Alloxanic Acid Inhibition of Urease by (Dr Clarke T Gray, Marcus S Brooke and John C Gerhart), 1936
Alloxan-Diabetic Rabbits A Low Concentration of certain Blood Constituents observed in Offspring of (Dr Otakar Sirek and Dr Anna Sirek), 456
Alloxanic Acid Inhibition of Urease by Alloxan and (Dr Clarke T Gray, Marcus S Brooke and John C Gerhart), 1936
Alloy (A New), for Gunmetal (Mond Nickel Co, Ltd), 1025
Alloys A Handbook of Lattice Spacings and Structures of Metals and (Dr W B Pearson), *review* by Dr J A Catterall, 841
  Martensitic Transformations in Metals and (Academician G V Kurdjumov), 1450
  The Physical Metallurgy of Magnesium and its (Prof G V Raynor), *review* by Dr J W Martin, 486
  Vacancies and other Point Defects in Metals and—a Symposium organized by the Institute of Metals, 1957 (Monograph and Report Series, No 23), *review* by Dr F C Thompson, 1765
Alloys (Aluminium–Zinc) Reversion of Nodules formed by the Grain Boundary Reaction in (Ryoji Watanabe and Shigeyasu Koda), 977
Alloys (Binary) Constitution of (Dr Max Hansen), second edition, prepared with the co-operation of Dr Kurt Anderko, *review* by Dr F C Thompson, 1765
Alloys (Iron-Silicon) A New Nitride Precipitate in (G R Booker and J Norbury), 1311
Alloys (Low-Carbon Iron-Silicon) X-Ray Diffraction Pattern of Carbide in (G Konoval, L Zwell, L A Gorman and W C Leslie), 1862
Alloys (Uranium and Thorium) Constitutional Diagrams of (Frank A Rough and Arthur A Bauer), *review* by Dr D E R Hughes, 925
Allpress, J G (Hambly, Prof A N, and) At the Second Australian Spectroscopy Conference (Infra-red Spectra can be used to follow some Solid State Reactions), 1196
Allred, W P Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Zone-refining of the Platinum-group Metals), 692
Allsopp, Dr A Effects of Gibberellic Acid on Juvenility in *Marsilea* and certain other Plants, 1575
Alpen, Edward L, and others Lack of Direct Effect of Erythropoietin on Human Erythroid Cells *in vitro*, 1228
Alper, Dr Tikvah Immediate and Low-level Effects of Ionizing Radiations, 1111
Alperin, Morton, and Stern, Marvin (edited by) Vistas in Astronautics—First Annual Air Force Office of Scientific Research Astronautics Symposium, *review* by D G King-Hele, 663
α-Aminoadipic Acid Enzymic Reduction of, by Yeast Enzyme (S Sagisaka and Prof K Shimura), 1709
α-Amino-β-(pyrazolyl-N) Propionic Acid, a New Amino-Acid from *Citrullus vulgaris* (Water Melon), (Dr F F Noe and Dr L Fowden), B A 69
α-Carbethoxy-L-Lysyl-L-serylglycine and its O-Phosphorylated Analogue Action of Trypsin on (Dr D Theodoropoulos, H Bennich, G Folsch and Prof O Mellander), 187
α-Casein The N-Terminal Amino-Acids of (Dr W Manson), 1393
α-Chains Haemoglobin 'Bart's', a Foetal Haemoglobin without (Abnormal Human Haemoglobins), (Dr J A Hunt and Dr H Lehmann), 872
α-Emitting Nuclides in Biological Material Spectroscopic Identification of (Prof W V Mayneord and C R Hill), 667
α-Globulins (γ- and) Production of, by the Isolated and Perfused Rat Spleen (Dr E Espinosa), 1801
α-Hydroxyacetylene Complexes of Platinum (II) Structure of (Dr J Chatt, L A Duncanson and R G Guy), 526
α-Ketoglutaric Acid and Pyruvic Acid in Blood, Cerebrospinal Fluid and Urine (Dr E Zelnicek), 727
α-Naphthalene Acetic Acid Effect of Indole Acetic Acid and, on the Growth, Flowering and Fruit Set in Sweet Potato (G Satyanarayana and Dr G Rangaswami), B A 73
α-Oxidation of Indoleacetonitrile (H F Taylor and Prof R L Wain), 1142
α-Radioactivity of Cerium-142 (F E Senftle, T W Stern and V P Alekna), 630
α- and β-Glycosides A Method for Distinguishing between, by the use of Plant Haemagglutinins (Lectins), (Dr O Mäkela), 111
αε-Diketopimelic Acid Synthesis of Dipicolinic Acid from (the late Joan F Powell and R E Strange) 878
Alpine Mineral Fissures (International Mineralogical Association Symposium on), 1909
Alston, Dr R E, and Turner, Dr B L Applications of Paper Chromatography to Systematics—Recombination of Parental Biochemical Components in a *Baptisia* Hybrid Population, 285
Alternative Synthesis and Behaviour on Hydrolysis 1-Glyceryl-2-*myo*-inositol Phosphate— (Synthesis and Properties of 1-Glyceryl-2-*myo*-inositol Phosphate), (R B Ellis and J N Hawthorne), 790
Altitude (High-) Nuclear Explosions Geophysical Effects of (W A Feibelman), 442
  Magnetic Effects resulting from Two (J A Lawrie, V B Gerard and P J Gill), B A 34
Altitude (High-) Research British Contribution to, 1776
Altman, K I Biological Effects of Low Doses of Ionizing Radiations (Breakdown of Muscle Collagen in Rats previously fed with Labelled Amino-Acids), 1112
Alumina Transparent Sintered—'Lucalox' (General Electric Company of America), 1107
Aluminium extracted by Neutral Citrate-Dithionite Reagent (W M H Saunders), 2037
Aluminium (High-Purity) Analysis for Magnesium in (C A Youngdahl and F E DeBoer), 54
Aluminium and Zirconium Volatile Methoxides of (Dr D C Bradley and Dr M M Faktor), 55
Aluminium Chloride (Anhydrous) A New Method for Working up Processing Mixtures containing (Dr T Széll and A Furka), 117, *erratum*, 595
Al_2O_3-SiO_2 Revised Equilibrium Diagram for the System (Shiger Aramaki and Prof Rustum Roy), 631
Aluminium–Zinc Alloys Reversion of Nodules formed by the Grain Boundary Reaction in (Ryoji Watanabe and Shigeyasu Koda), 977
Alvāger, T and others A New Method for Studying the Functioning of the Lungs, 372
Alvarenga Prize for 1959 awarded to Dr Hilary Koprowski by the College of Physicians of Philadelphia, 683
Amaha, Prof Mikio, and Nakahara, Tomoko Rôle of the Glycolytic Enzyme System in the Germination of Spores of *Bacillus coagulans* var *thermoacidurans* 1255
Ambartsumian, Dr V A Elected a foreign associate of the United States National Academy of Sciences, 95
Ambler, Dr H R Appointed scientific adviser to the United Kingdom High Commissioner in New Delhi, 1448, work of, 1448
Ambler, R P, and Rees, M W ε-N-Methyllysine in Bacterial Flagellar Protein, 56
Ambrose, Dr D Gas Chromatography, 328
America (Arctic North) The Benthos of Soft Sea-bottom in (Dr D V Ellis), B A 79
America (North) The Evolution of (Dr Philip B King), *review* by Dr J W Cowie, 1600
  The Geological Development of, *review* by Dr J W Cowie, 1600
  The Mammals of (Prof E Raymond Hall and Dr Keith R Kelson), *review* by Peter Crowcroft, 1524
America (South) Transport of Driftwood from, to Tasmania and Macquarie Island (Prof H N Barber, Dr H E Dadswell and H D Ingle), 203
American Academy of Arts and Sciences Election of new Fellows and Foreign Honorary Members, 409
  Re-election of Dr Kirtley F Mather as president, 410
American Academy of Political and Social Science Annals, May, 1959, Partnership for Progress—International Technical Co-operation, *review* by R Brightman, 1673
American Association for the Advancement of Science, and Unesco International Oceanographic Congress, 1605
American Indians (South) Frequency of the New Blood Group Antigen Js^a among (Dr Miguel Layrisse and Dr Zulay de Layrisse), 640
American Industry Funds for Research and Development Performance in (United States National Science Foundation, Reviews of Data on Research Development No 14), 1022
American Institute of Mining, Metallurgical and Petroleum Engineers (Metallurgical Society of the) New series of books entitled Metallurgical Society Conferences, 1362
American Journal of Science Radiocarbon Supplement, Vol 1, 1686
American Museum of Natural History Bulletin, Vol 117, Art 6, Studies on Social Groupings in Fishes (Dr C M Breder, Jr), 865
  Bulletin, Vol 117, Art 5, A Taxonomic Revision of the Spotted Skunks of the Genus *Spilogale* (R G van Gelder), 1024
  James Arthur Lecture on the Evolution of the Human Brain—The Discrete and the Diffuse in Nervous Action (Prof D P C Lloyd), 1777
American Philosophical Society Transactions, New Series, Vol 48, Part 6, Preliminary Archaeological Investigations in the Sierra de Tamaulipas, Mexico (Dr Richard S MacNeish), 593
American Population (Normal) An Association between Abo Blood Groups and Fertility in a (Dr T Edward Reed and Dr J H Ahronheim), 611

American Society of Mechanical Engineers Colloquium on Mechanical Impedance Methods for Mechanical Vibrations, 1958 (edited by R Plunkett), *review* by Prof R E D Bishop, 1764
American (North) Mammals, *review* by Peter Crowcroft, 1524
American and European Working Conditions in Industry Fitting the Job to the Worker—a Survey of (European Productivity Agency of the Organization for European Economic Co-operation, Project 335), 422
Amesz, J (Duysens, Prof L N M, and) Energy Transfer with special reference to Biological Systems (Quantum Requirements of Diphosphopyridine Nucleotide in Photosynthesis), 690
Amides (Carbon-14-labelled Amino-Acids and) Translocation of, in the Stem of young Soya Bean Plants (C D Nelson and P R Gorham), 855
Amin, A H, and Mehta, D R A Bronchodilator Alkaloid (Vasicinone) from *Adhatoda vasica* Nees, 1317
Amine Oxides Prophylactic Effects of, in Radiation Injury in Mice (Dr Thomas J Haley, Dr Anna M Flesher and Dr Nathan Komesu), 198
Amines (Adrenal Catechol), induced by Reserpine Abolition by Chlorpromazine of the Inhibiting Effect of Iproniazid on the Depletion of (F Camanni, Dr G M Molinatti and M Olivetti), B A 65
Amines (Aliphatic) and related Compounds High-Voltage Paper Electrophoresis of (Dr D Gross), 1633
Amines (Catechol) Effects of 1,4-Dihydrazinophthalazine on Organ Content and Adrenal Medullary Secretion of (M Bygdeman and L Stjarne), 1646
Amino-Acid (New) from *Citrullus vulgaris* (Water Melon) α-Amino-β-(pyrazolyl-N) Propionic Acid, a (Dr F F Noe and Dr L Fowden), B A 69
Amino-Acid (Carbohydrate—) Inter-relations in Brain Cortex *in vitro* (M M Kini and Prof J H Quastel), 252
'Amino-Acid Imbalance' Effect of, on Growth and Vitamin A Storage in the White Rat (M Rechcigl, jun, S Berger, J K Loosli and H H Williams), 1404
Amino-Acid Phosphates under Physiological Conditions Spontaneous De-amination of (Dr Mella Paecht and Prof A Katchalsky), 1489
D-Amino-Acid Oxidase Apo-Protein Binding of the Sulphydryl Group in, with Flavin Adenine Dinucleotide (Dr Kunio Yagi and Takayuki Ozawa), 1227
D-Amino Acid Oxidase Apo-Protein and Benzoate Change of Absorption Spectrum of Flavin Adenine Dinucleotide by its Binding with both (Dr Kunio Yagi, Takayuki Ozawa and Minoru Harada), 1938
d-Amino-Acid Oxidase Systems Effect of Chlorpromazine upon Isolated (Dr Andrew Lasslo and Anne L Meyer), 1922
Amino-Acids A New Two-Dimensional Paper Chromatographic Method applied to the Separation of (C S Knight), 1486
Amino-Acids of α-Casein The N-Terminal (Dr W Manson), 1393
Amino-Acids of Red Sulphur Bacteria (H Mukherjee), 1742
Amino-Acids from Sucrose Biosynthesis of some, by Germinating Uredospores of Wheat Stem Rust, Race 15*B* (B Kasting, A J McGinnis and W C Broadfoot), 1943
Amino-Acids (2 4-Dinitrophenyl) Detection of, on Paper Chromatograms (Dr A H Maddy), 1397
Amino-Acids and Amides (Carbon-14-labelled) Translocation of, in the Stems of young Soya Bean Plants (C D Nelson and P R Gorham), 855
Amino-Acids and Peptides on Paper A Two-Dimensional System for the Separation of (Virginia Richmond and Brian S Hartley), 1859
β-Amino-*iso*butyric Acid in Mongolism Urinary Excretion of (Dr Thomas L Perry, Dr Kenneth N F Shaw and Dr Dorothy Walker), 1970
β-Amino-*iso*butyric Acid Excretors High Prevalance of High-Level, in Micronesians (Dr B S Blumberg and Dr S M Gartler), 1990
α-Amino-β-(pyrazolyl-N) Propionic Acid, a New Amino-Acid from *Citrullus vulgaris* (Water Melon), (Dr F F Noe and Dr L Fowden), B A 69
Amino- and other Organic Acids Two-Dimensional High-Voltage Paper Electrophoresis of (Dr D Gross), 1298
Aminoaciduria caused by Maleic Acid Significance of Lactose in the Diet in (Stefan Angielski and Jerzy Rogulski), 276
α-Aminoadipic Acid Enzymic Reduction of, by Yeast Enzyme (S Sagisaka and Prof K Shimura), 1709
p-Aminobenzoic Acid Antagonism of the Oxidative Dissimilation of, by *p*-Aminosalicylic Acid (Prof Norman N Durham and Jerry S Hubbard), 1398
γ-Aminobutyric Acid Quantitative Changes in, induced by Low Temperature in Rice Plants (F Zsoldos), 280
γ-Aminobutyric Acid Content of Rat Brain Increase in the, after Ingestion of Ethanol (Dr H -M Hakkinen and E Kulonen), 726
2-Aminoethane Phosphonic Acid Isolation of, from Rumen Protozoa (Masaaki Horiguchi and Makoto Kandatsu), 901
2-Aminofluorene Possible Relation between Carcinogenicity and Ease of Hydrolysis *in vitro* of Derivatives of (Prof Mary F Angus and Francis E Ray), 2018
1-*p*-Aminophenoxy-5-phthalimidopentane Loss of Wool in Sheep caused by (Dr D L Hughes), 1644
p-Aminosalicylic Acid Antagonism of the Oxidative Dissimilation of *p*-Aminobenzoic Acid by (Prof Norman N Durham and Jerry S Hubbard), 1398
Ammonia Inhibition of Reduced Diphosphopyridine Nucleotide Oxidation by (R T Wedding and H M Vines), 1226
Amoeba Biology of (Monica Taylor), 1371
AMPERE (Colloque), and the Radiofrequency Spectroscopy Group Joint Discussion on Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 157
Amplitude-Modulation Radio-Telemetry of Nerve Action Potentials (Roger M Morrell), 1129
Ampol Petroleum, Ltd Grant of £2,500 towards the cost of the third Summer School for Science Teachers of the Australian Nuclear Research Foundation, 1108
AMSOC's Mohole A Bore-Hole to the Earth's Mantle— (Gordon Lill and Willard Bascom), 140
Amylase by *Penicillium chrysogenum* Inhibitory Effect of Fungistatic Antibiotics on the Production of (Dr I Horvath and A Szentirmai), 57
An Foras Taluntais (The Agricultural Institute of Ireland) Dublin, 28
    Appointment of Dr T Walsh as director, 29
    Appointment of Dr L B O'Moore as chief of the Animal Production Division, 29
    Appointment of J J Byrne as chief of the Rural Economy Division, 29
    Award of junior postgraduate agricultural research scholarships, 1612
    Division of Plant Sciences and Crop Husbandry, 1847
Anaemic Dogs after Nephrectomy Disappearance of the Erythropoietic Factor from Plasma of (Dr Jean-Pierre Naets), 371
Anaerobiosis (Aerobiosis and) Fluorescence Measurements of Mitochondrial Pyridine Nucleotide in (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Prof Britton Chance and Dr Bo Thorell), 931
Anaesthetic for Fishes Urethane as a Carcinogen and as an (Dr J N Ball and Prof P N Cowen), 370
Anaesthetized Dog 'Supercarbia' in the (Dr G R Graham, D W Hill and J F Nunn), 1071
Analgesic Identification of Phenazocine, a Potent New (Dr E G C Clarke), 451
Analogue (Histidine), of Hypertensin II Synthesis of a Protected Heptapeptide related to the (Dr D Theodoropoulos), 1634
Analogue (O-Phosphorylated) Action of Trypsin on α-Carbethoxy-L-lysyl-L-serylglycine and its (Dr D Theodoropoulos, H Bennich, G Folsch and Prof O Mellander) 187
Analogues (Purine and Pyrimidine) Effect of, on Reversion of a Tryptophan-requiring Strain of *Escherichia coli* (C O Doudney and F L Haas), 114
Analogues and Precursors (Nicotinamide) Reversal of Effects of 2-Substituted Thiadiazoles by (Dr Irwin H Krakoff, Corrine R Lacon and Dr David A Karnofsky), 1805
Analogy with Muscle Contraction Permanent Set, Supercontraction and Urea-Bisulphite Solubility—the Proton-Transfer Nature of some changes in Keratin and the (Dr P T Speakman), 339
Analyser (The Infra-Red Gas), as a Means of Measuring the Carbon Dioxide Output of Individual Insects (Dr A G Hamilton), 367
Analyser (Narrow-Band Spectrum) Observations of the Fine Structure of Enhanced Solar Radio Radiation with a (Oystein Elgaroy), 887
Analyses (Activation), of Six Trace Elements in Marine Biological Ashes Some (R Fukai and Prof W W Meinke), 815
Analysing the Development of Connective Tissue Diaphragms for (Prof Hans Selye), 701
Analysis Classical Chemical, *review* by Dr William I Stephen, 1756
    Clerical Salaries (1958), (Office Management Association), 698
    Colorimetric Methods of, including Photometric Methods (Dr Foster Dee Snell and Dr Cornelia T Snell, assisted by Dr Chester Arthur Snell), Vol 2A, *review* by J King, 1522
    Food, *review* by Dr V H Booth, 1347
    Genetic, *review* by J Maynard Smith, 752
    Linear Structural (Prof P B Morice), *review* by R K Livesley, 1600
    Nuclear Energy and, *review* by G W C Milner, 1524
    Radioactivation (International Atomic Energy Agency and the International Council of Scientific Unions Symposium on), 951
    Soil Chemical (Prof M L Jackson), *review* by J M Bremner, 1093
Analysis of Kinetics and Mechanism Behaviour of Enzymes, an (Dr John M Reiner), *review* by Dr J B Chappell, 388
Analysis of Light Hydrocarbons (G R Primavesi), 2010
Analysis for Magnesium in High-Purity Aluminium (C A Youngdahl and F E DeBoer), 54
Analysis of Noise and Vibration New Techniques in the (Acoustics Group of the Physical Society and the Institute of Physics Symposium on), 415
Analysis of Permanent Gases by Gas Chromatography using a Radioactive Ionization Type Detector (V Willis), 894
Analysis of Satellite Orbits Density of the Upper Atmosphere from—Further Results (D G King-Hele), 1267
Analysis (Chemical), of Foods and Food Products (Dr Morris B Jacobs), third edition, *review* by Dr V H Booth, 1347
Analysis (Classical) Linear Operations and, *review* by Prof L S Goddard, 1763
Analysis (Contour), in Equatorial Meteorology Value of (D H Johnson and Dr H T Morth), 1372
Analysis (Differential), of the Effects of Phenothiazine-Tranquillizers on Emotional and Motor Behaviour in Experimental Animals (Dr M Taeschler and Dr A Cerletti), 823
Analysis (Functional) Introduction to (Prof Angus E Taylor), *review* by Prof T A A Broadbent, 666
Analysis (Genetic) Trends in (Prof G Pontecorvo), *review* by J Maynard Smith, 752
Analysis' ('*LO*-), as an Aid in the Study of Fungal Spore Morphology (Dr M M Payak), 738
Analysis (Neutron Activation) Determination of Chlorine in Muscle Tissues by (Dr Jonas Bergstrom), 1504
Analysis (Numerical), and Partial Differential Equations (George E Forsythe and Paul C Rosenbloom), *review* by Prof T A A Broadbent, 576
Analysis (Post-Exposure), of Organic Compounds in the Blood by a Rapid Infra-red Technique (Dr R D Stewart, D S Erley, T R Torkelson and C L Hake), 192
Analysis (Proximate), of Marine Standing Crops (Dr T R Parsons and Dr J D H Strickland), 2038
Analysis (Structural) Matrix Algebra in, *review* by R K Livesley, 1600
Analysis (Structure), and Experimental Techniques (Institute of Physics Conference on), 857
Analysis (Titrimetric) Nomenclature in (Committee of the Analytical Chemistry Section of the International Union of Pure and Applied Chemistry), 1686
Analysis and Probability Some Aspects of (Irving Kaplansky, Marshall Hall, Jr, Edwin Hewitt and Robert Fortet), *review* by D G Kendall, 214
Analytic Theory of Numbers Some Recent Progress in the (Prof H Davenport), 1533
Analytical Chemistry (edited by M T Kelley), Vol I, *review* by G W C Milner, 1524
Analytical Chemistry (A G Jones), *review* by Dr A M G Macdonald, 1677
Analytical Chemistry Advanced (Prof Louis Meites and Prof Henry C Thomas), *review* by Dr W I Stephen, 1525
    Comprehensive (edited by Prof Cecil L Wilson and David W Wilson), Vol Ia Classical Analysis, *review* by Dr William I Stephen, 1756
    Talanta Medal for outstanding contributions to, 956

Analytical Chemistry at Birmingham, 679
Analytical Chemistry in Nuclear Reaction Technology Third Conference on, 26
Analytical Measurements, Ltd Analytical Pocket *p*H Meter, 683
Analytical Pocket *p*H Meter (Analytical Measurements, Ltd), 683
Anastomoses (Vein), in the Leaves of Long Shoots of *Ginkgo biloba* (Dr Howard J Arnott), 1336
Anastomosis Establishment of Parenchymatous Spleno-Pulmonary Venous (Dr George R Walker, Dr Paul Field and Dr Patrick E Conen), 703
Anatomy Renaissance, *review* by Dr A R Hall, 1761
Anatomy (Isagogae Breves), (Jacopo Berengario da Carpi), translated with an Introduction and Historical Notes by L R Lind, and with Anatomical Notes by Paul G Roofe, *review* by Dr A R Hall, 1761
Anatomy and Biology The Wistar Institute of, Philadelphia (Dr R E Billingham and Dr H Koprowski), B A 6
Ancient Buildings, Society for the Protection of (Central Council for the Care of Churches and the) Report on the Conservation of English Wall-paintings, 1119
Ancient Egyptian and Cnidian Medicine (Robert O Steuer and J B de C M Saunders), *review* by Dr Douglas Guthrie, 662
Ancient Near East Myth and Ritual in the (Prof E O James), *review* by Prof Norman W Porteous, 1972
Ancient Seas Determination of the Temperatures of, by the Measurement of the Oxygen Isotopes Ratio in Fossil Calcareous Organisms (Y A Birstein), 1025
Andenabhang Sudperus Ein neuer *Asthenes* (Aves, Furnariidae) von der Kuste und dem westlichen (Maria Koepcke), (Beiträge zur Neotropischen Fauna), *review* by Dr F A Turk 1177
Andengebietes Zur Kenntnis der Pseudoscorpioniden-Fauna des (Max Beier), (Beiträge zur Neotropischen Fauna), *review* by Dr F A Turk, 1177
Anders, Edward, and Limber, Dr D Nelson Origin of the Worzel Deep-Sea Ash, 44
Anderson, B A Survey of Soils in the Kongwa and Nachingwea Districts of Tanganyika, *review* by Dr R M S Perrin, 1901
Anderson, Sir David Retirement as director of the Royal College of Science and Technology, Glasgow, 151 , work of, 151
Anderson, Dr D J Appointed to the University of London readership in physiology in relation to dentistry at Guy's Hospital Medical School, 595
Anderson, E S Mutation in the Type-determining Phages of *Salmonella typhi*, 1822
Anderson, Prof J S Opening Address at the second Australian Spectroscopy Conference, 1195
  Appointed director of the National Chemical Laboratory, 1610 , work of, 1610
Anderson, Prof J S , and Klemperer, D F 'Thermal Regeneration' in the Nickel–Oxygen System, 899
Anderson, N F , and others An Improved Technique for Intravenous Injection of Newborn Rats and Mice, 1952
Anderson, W , and others Current Trends of Strontium-90, Strontium-89 and Caesium-137 Levels in Milk, 89
Anderson Hospital and Tumour Institute of the University of Texas Fourteenth Annual Symposium on Fundamental Cancer Research (Cell Physiology of Neoplasia), 1451
Andree, Richard V Selections from Modern Abstract Algebra, *review* by Prof T A A Broadbent, 301
Andrew, E R Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 157
Andrew, Capt J At the Annual General Meeting and Conference of the Mathematical Association (The Southampton Port Operation and Information Service), 32
Andrew, Dr Warren Textbook of Comparative Histology, *review* by Dr T Kerr, 752
Andrewes, Dr C H , and others Myxomatosis—Present Position and Future Prospects in Great Britain, 1179
Andrews, Dr Donald H The Road to Knowledge (New Relationships between Art and Sciences), B A 8
Andrews, E D (Hart, L I , and) Effect of Cobaltic Oxide Pellets on the Vitamin B_{12} Content of Ewes' Milk, 1242
Andrysek, O (Liebster, J , and) Labelling of Rose Bengal with Iodine-131 by Radioactive Exchange, 913
Anemia phyllitides Control of Antheridium Formation in the Fern Species (Dr Ulrich Naf), 798
Anemone (The Sea), *Calliactis parasitica*, and the Hermit Crab (*Eupagurus bernhardus*), (Dr D M Ross), 1161
Aneuploid Deoxyribonucleic Acid Content of Human Carcinomas (H F Stich and H E Emson), 290
Anfinsen, jun , Dr C B *Obituary* of Prof Kaj U Linderstrøm-Lang, 314
Angel, A , and others Fusion Frequency and Light Quantity, 1873
Angielski, Stefan, and Rogulski, Jerzy Significance of Lactose in the Diet in Aminoaciduria caused by Maleic Acid, 276
Anglesey The County of—Soils and Agriculture (E Roberts), (Memoirs of the Soil Survey of Great Britain—England and Wales), (Agricultural Research Council), 154
Angola Native Life in, 236
Anguilla vulgaris Turt Discrimination between Ebb and Flood Tide in Migrating Elvers, by means of Olfactory Perception (F Creutzberg), 1961
Angus, Capt K C Oil Pollution of the Sea (Preventive Measures taken by the Canadian Government), 950
Anhydrase (Carbonic), in the Deciduoma of the Rat (Dr T H Johnson, Dr C Lutwak-Mann and Prof M C Shelesnyak), 961
Anhydrase (Carbonic), in Erythrocytes Influence of X-Rays on the Activity of, and on their Haemolytic Resistance (A Lauwers, J Van Bavinchove and W Dierick), 111
Anhydrite (Insoluble) Transition of Calcium Sulphate Hemihydrate to (Chikara Mitsuki and Masayoshi Kita), 1481
Anhydrous Aluminium Chloride A New Method for Working up Processing Mixtures containing (Dr T Szell and A Furka), 117, *erratum*, 595
Anhydrous Formic Acid Action of, on Peptides and Proteins (H Kienhuis, G Blasse and J Matze), 2015
Aniba Aubl (Genus) Phylogeny of the—a Comparative Morphological and Chemical Observation (Walter B Mors, Otto Richard Gottlieb and Ida de Vattimo), 1589
Animal Behaviour (Dr John Paul Scott), *review* by Dr F Fraser Darling, 302
Animal Clocks (British Association for the Advancement of Science, Section D (Zoology), Symposium on), 763, 1534
Animal Ecology Practical (W H Dowdeswell), *review* by Prof J B Cragg) 1262
Animal Health Trust Awards for 1959-60, 771
  H M the Queen to become patron of the, 1190
Animal Joints Mechanism of—Sponge-hydrostatic and Weeping Bearings (Dr C W McCutchen), 1284 , Experimental Evidence for Weeping Lubrication in Mammalian Joints (P R Lewis and Dr C W McCutchen), 1285
Animal Life South African—Results of the Lund University Expedition in 1950-1951, Vol 5, (edited by Bertil Hanstrom, Per Brinck and Gustaf Rudebeck), *review*, 133
Animal Organism Thiosulphate Metabolism in the (Prof Boleslaw Skarzynski, Tadeusz W Szczepkowski and Miroslawa Weber), 994
Animal Populations Exploitation of Natural (British Ecological Society Symposium on), 1451
Animal Research at the Commonwealth Scientific and Industrial Research Organization, 1532
Animal Tissue Extracts Occurrence and Quantitative Determination of 2-Dimethylaminoethanol in (Dr Conrad G Honegger and Ruth Honegger), 550, *erratum*, 1986
Animal Viruses Inactivation of some, by Hydroxylamine and the Structure of Ribonucleic Acid (Dr Richard M Franklin and Dr Eberhard Wecker), 343
Animal World of Netherlands New Guinea (Dr L D Brongersma), *review* by J E Hill, 1251
Animals Orientation of, to Polarized Light (Dr H Kalmus), 228
  Parasitic (Dr Geoffrey Lapage), second edition, *review* by Dr C A Wright, 1011
Animals in East Africa Looking for (E H Tong), 1535
Animals to survive Freezing at an Extremely Low Temperature Prefreezing as a Method enabling (Eizo Asahina), 1003
Animals in Hiding (D G Lambert), 1535
Animals (Control and Stimulated) Quantitative Assay of Compounds in Isolated, Fresh Nerve Cells and Glial Cells from (Prof Holger Hyden), 433
Animals (Domestic) Reproduction in (edited by H H Cole and P T Cupps), Vol I, *review* by Dr S J Folley, 1091
Animals (Experimental) Differential Analysis of the Effects of Phenothiazine-Tranquillisers on Emotional and Motor Behaviour in (Dr M Taeschler and Dr A Cerletti), 823
Anion Role of the, in Magnesium Uptake from Foliar Applications of its Salts on Apple (M Allen), 995
Anion Exchangers based on Cellulose (Dr A O Jakubovic), 1065
Anionic Derivatives of Synthetic Polyglucoses Reduction of Toxicity of Cationic Macromolecules by Complexing with (P T Mora, B D Young and M J Shear), 431
Anisotropy (Diamagnetic), in Crystals Intermolecular Distances and, as Measures of the Polarity of Benzene and Borazole Substituents (Dame Kathleen Lonsdale), 1060
Anisotropy (North–South), and Anticipatory Increase of Intensity associated with the Cosmic-Ray Storm of February 11, 1958 (Dr V Sarabhai and R Palmeira), 1204
Annau, E Preparation of a Highly Purified Carbohydrate-free Johnin Protein, 1642
Annealing of Recoil Damage by Ultra-Violet Light (R F C Claridge and Dr A G Maddock), 1932
Annison, E F , and Lewis, D Metabolism in the Rumen, *review* by Dr D P Cuthbertson, 839
Anno, Toshinobu Awarded a Japanese Fellowship in Chemistry for 1959-60 by the Ramsay Memorial Fellowships Trustees, B A 16
Annual Review of Entomology, Vol 4 (edited by Edward A Steinhaus and Ray F Smith), *review* by Dr P T Haskell, 489
Annual Review of Pharmacology, 943
Annual Review of Physiology (edited by Victor E Hall, in association with Frederick A Fuhrman and Arthur C Giese), Vol 21, *review* by Prof D C Harrison, 838
Anoestrus Period of Laboratory Cats Reduction in the, by Increased Illumination (Dr Patricia P Scott and Marny A Lloyd-Jacob), 2022
Anomalies in the Behaviour of the F2 Layer of the Ionosphere Two (Sheila Croom, Audrey Robbins and J O Thomas), 2003
Anomalous 'Common Strontium' in Granite (W Compston and Dr P M Jeffery), 1792
Anomalous Continuum Radiation from Jupiter (Dr Eugene E Epstein), 52
Anomalous Genetic Interactions observed in *Bacillus subtilis* (M Kohiyama and Y Ikeda), 208
Anoplotermes (New Neotropical Element), in Indian Termite Fauna (Dr M L Roonwal and O B Chhotani), 1967
Ansell, Dr G R A Biochemist's Guide to the Nervous System, *review*, 1261
Antagonism of the Oxidative Dissimilation of *p*-Aminobenzoic Acid by *p*-Aminosalicylic Acid (Prof Norman N Durham and Jerry S Hubbard), 1398
Antarctic Natural Remanent Magnetization of Pre-Cambrian Gneiss of Ongul Islands in the (T Nagata and Y Shimizu), 1472
  Research in the, during 1960 (Sir Vivian Fuchs), 851 , American Programme, 852
  An Unusual Diatom from the (E J Ferguson Wood), 1962
Antarctic Party, British, 1985
Antarctic Glacier Ice Creep Tests on (Malcolm Mellor), 717
Antarctic Ice Sheet Surface Topography of the (Dr J F Nye), 786
Antarctic Snow Samples Oxygen Isotope Variations in (Dr R Gonfiantini and Prof E Picciotto), 1557
Antarctic Stations (New Zealand) Diurnal Variation of Aurora and Geomagnetic Disturbance at (Dr T Hatherton and G G Midwinter), 889
Antarctica Fossil Pollen from Seymour Island (Lucy M Cranwell), 1782
  Palaeomagnetism of some Dolerite Intrusions from the Theron Mountains and Whichaway Nunataks, (D J Blundell and P J Stephenson), 1860
Anterior Pituitary Gland A Dense Laminar Structure found in Conjunction with Cell Membranes in the (Barbara G Barnes), 651

Anterior Pituitary-like Activity of Rumen Contents (Dr F A Soliman), 1723
Anthelminthic Property of *Artemesia monosperma* grown in Egypt *In vitro* Study of the (A Sharaf, Z F Ahmed and F Abdel Moneim), 647
Antheridium Formation in the Fern Species *Anemia phyllitides* Control of (Dr Ulrich Naf), 798
Anthony, Dr H D Science and the Humanities, *review*, 131
Anthropologist at Work An—Writings of Ruth Benedict (Dr Margaret Mead), *review* by Prof E E Evans-Pritchard, 301
Anti-A Haemagglutinins from a Non-Leguminous Plant, *Hyptis suaveolens* Poit (Dr G W G Bird), 109
Anti-Atherogenic and Endocrine Actions The C_{17}-OH Group of Œstradiol—Relationships between its (Dr Manuel Rene Malinow, Alvaro L Gimeno, Amanda A Pellegrino-Iraldi, Martha A Fernandez-Gimeno, Jorge L Lacuara and Jaime A Mogu'levsky), 1720
Antiadrenergic Compounds New (A L A Boura, F C Copp and A F Green), B A 70
Antibacterial Substances of Coniferous Seedlings at Different Stages of their Development (R Vamos and L Vida), 915
Antibiotic Monamycin, a New (Prof C H Hassall and K E Magnus), 1223
  A New Trichothecin-like Antifungal (E T Glaz, Eszter Scheiber, J Gyimesi, I Horvath, Katalin Steczek, A Szentirmai and G Bohus), 908
Antibiotic Production as a Function of Spore Formation in *Bacillus licheniformis* (Robert W Bernlohr and G D Novelli), 1256
Antibiotics Neuromuscular Blocking Action of some (G Bezz and G L Gessa), 905
Antibiotics (Fungistatic) Inhibitory Effect of, on the Production of Amylase by *Penicillium chrysogenum* (Dr L Horvtah and A Szentirmai), 57
Antibodies (Incomplete) Loss of Plasticity of Erythrocytes coated with (Prof C T Nicolau, P Teitel and M Fotino), 1808
Antibodies (Thyroid) Detection of, using Bentonite Particles (Dr J A M Ager, Dr M S R Hutt and G Smith), 478
Antibody Recovery of Infectious Nucleic Acid from Tobacco Mosaic Virus inactivated by (Dr Irving Rappaport), 1732
Antibody (Agglutinating Auto-), (Panagglutinin) Production of an, Active upon Tanned Erythrocytes in the Rabbit (P O Hubinont, P Ghysdael and O Thys), 1250
Antibody (Precipitating) Promoting Effect of Urea on the *in vitro* Passive Sensitization of Isolated Plain Muscles with (R Binaghi, Dr B N Halpern, P Liacopoulos and T Neveu), 1805
Antibody and Complement Release of Compounds containing Diaminopimelic Acid from *Vibrio metchnikovi* treated with (Dr F Shafa and Dr M R J Salton), 1341
Antibody Formation Specific Inhibition of, during Immunological Paralysis and Unresponsiveness (Dr E Sercarz and Dr A H Coons), 1080
Antibody Globulin *In vitro* Labelling of, by Tritium Exchange (Dr P C Rajam and Anne-Louise Jackson), 375
Antibody Status of Mice and Response of their Litters to Parotid Tumour Virus (Polyoma Virus), (Lloyd W Law, Clyde J Dawe, Wallace P Rowe and Janet W Hartley), 1420
Anticipatory Increase of Intensity associated with the Cosmic-Ray Storm of February 11, 1958 , North–South Anisotropy and (Dr V Sarabhai and R Palmeira), 1204
Anticoagulant (Bridge Blood) Neutralization of (Dr F Nour-Eldin), 1419
Anticoagulant Activity of Human Arterial Mucopolysaccharides (Prof John E Kirk), 369
Anti-coagulant Drug Pelentane or Thromexane Isomeric O-Methyl Ethers of Ethyl di-(4-hydroxycoumarinyl-3)-Acetate, the (Dr Eduard Knobloch), 1568
Anticoagulating System (Physiological) Interellations between the Blood Coagulating System and the (Prof P A Kudrjashov), 454
Antidiuretic Effect of Vasopressin Mechanism of the (Dr Tsutomu Kashiwagi), 991
Antifungal Antibiotic A New Trichothecin-like (E T Glaz, Eszter Scheiber, J Gyimesi, I Horvath, Katalin Steczek, A Szentirmai and G Bohus), 908
Antifungal Substance, 6-Methoxybenzoxazolinone Isolation of the, from Field Corn (*Zea mays L*) in Canada (N J Whitney and C G Mortimore), 1320
Antigen Js^a (New Blood Group), among South American Indians Frequency of the (Dr Miguel Layrisse and Dr Zulay de Layrisse), 640
Antigen Sw_a A 'New' Human Blood Group (T E Cleghorn), 1324
Antigenic Components from Isolated Nuclei Transplantation Immunity—Separation of (Andre Castermans and Andre Oth), 1224
Antigenic Substances Coating of Red Blood Cells with (Dr K Deutsch), 278
Antigens (*Iso-*), of Rabbit γ-Globulin (S Dubiski, Danuta Skalba, Anna Dubiska and Dr A Kelus), 1811
Anti-Knock Mechanism of (Dr A B Callear and Prof R G W Norrish), 1794
Antileukaemic Activity of Polyporic Acid (J F Burton and B F Cain), 1326
Antilipaemic X Factor of the Unsaponifiable Fraction of Crude Vegetable Oils Chromatographic Identification of the (Prof M C Nath, A Saikia and B I Uppin), 1635
Anti-Locust Research Centre, London Appointment of Dr P T Haskell as deputy director, 410
Antimetabolic Action of Vitamin K (Prof E Quagliariello, C Saccone, E Rinaldi and M R Alioto), 820
Antimetabolites (New), from Vitamin B_{12} (G M Timmis and Dr S S Epstein), 1383
Antimineralocorticoid Action of some Saluretic Sulphonamides (Dr G C Kennedy and Dr J D Crawford), 1492
Anting, *review* by T H Hawkins, 665
Antiquities Chemistry in the Preservation of (British Association for the Advancement of Science, Sections B (Chemistry) and H (Anthropology) Discussion on), 585
Anti-Rh Serum Specific Inhibition of, by 'Unnatural' Sugars (Dr William C Boyd, Marjorie H McMaster and Eugenia Waszczenko-Zacharczenko), 989
Anti-Shielding Factor (Quadrupole), in Copper (E A Faulkner), 442
Anti-Staling Agents Interaction of, with Starch (Prof E J Bourne, A I Tiffin and Dr H Weigel), 547
Antiviral Chemotherapeutic Activity of Isatin β-thiosemicarbazone in Mice infected with Rabbit-pox Virus (D J Bauer and F W Sheffield), 1496
Ants and Form Reversal in Aphids (Dr Bruce Johnson), 740
Aorta (Dorsal), of certain Fishes , A Ligament in the (Dr L L de Kock and Dr S Symmons), 194
Aphids Ants and Form Reversal in (Dr Bruce Johnson), 740
Apices (Root) Reorganization of, after Irradiation (F A L Clowes), 1025
Apinis, Dr A E Mapping Vegetation, B A 23
Apis mellifica (L) Isolation of 24-Methylene-cholesterol from Honey Bees (Dr M Barbier, Prof T Reichstein, Dr O Schindler and Prof E Lederer), 732
Aplacophorous Mollusc *Neomenia carinata* Tullberg Development of the (Dr T E Thompson), 122
Apo- and Co-dehydrogenases Interaction of Streptomycin and Dihydrostreptomycin with (Prof K Michalska), 987
Apo-Protein (D-Amino-Acid Oxidase) Binding of the Sulphydryl Group in, with Flavin Adenine Dinucleotide (Dr Kunio Yagi and Takayuki Ozawa), 1227
Apo-Protein (D-Amino Acid Oxidase), and Benzoate Change of Absorption Spectrum of Flavin Adenine Dinucleotide by its Binding with both (Dr Kunio Yagi, Takayuki Ozawa and Minoru Harada), 1938
Apomict, *Aerva tomentosa* Forsk *In vitro* Culture of the Inflorescences, Flowers and Ovaries of an (Prem Murgai), 72
Apothecaries of London, Worshipful Company of Foundation of a Faculty of the History of Medicine and Pharmacy, 1448
  Inaugural Lecture to the Faculty of the History of Medicine and Pharmacy (Canon Charles E Raven), 1448
Apparatus (Electronic), for Biological Research (P E K Donaldson), *review* by W J Perkins, B A 4
Apparatus and Methods of Oceanography (Dr H Barnes), Part I, Chemical, *review* by F A J Armstrong, 299
Apparent Observation of Solar Corpuscular Clouds by Direct Continuous-Wave Reflexion (Dr John D Klaus and W Reed Crone), 965
Appearance of Crystalline Needles in Monkey Kidney Cell Cultures infected with Poliomyelitis Virus and Incubated at 22-30° C (Dr Esther Tenenbaum), 1657
Appearance of Granules in the Cytoplasm of Tumour-Cell Cultures in Contact with Lysozyme (Dr Carlo Callerio), 202, *erratum*, 508
Appearance of Mutants with Respiration-deficiency in *Staphylococci* Rate of (G V Gause, G V Kochetkova and N A Sorbaeva), 1821
Apple Role of the Anion in Magnesium Uptake from Foliar Applications of its Salts on (M Allen), 995
Apple Fruitlets A Kinin in (Dr P L Goldacre and Dr W Bottomley), 555
Apple Stem Wounds *Gloeosporium* in (R O Sharples), 243 , (A T K Cooke), 244
Apple Tissue Oxidation of Krebs Cycle Acids by (M D Hatch, J A Pearson, A Millerd and R N Robertson), 506
Apples Nature of the Olefines produced by (Dr F E Huelin and B H Kennett), 996, *errata*, 1535 , (Dr D F Meigh), 1072
Appleton, Sir Edward Photography in the International Geophysical Year, 1032
Application of Biometrical Genetics to Behaviour in Rats (Dr P L Broadhurst), 1517
Application of the Mass Spectrometer to Polysaccharide Chemistry (Dr F A Finan and Dr R I Reed), 1866
Application of Science in Industry, 1827
Application to the Study of Rat Adrenal Lipids Use of Porter–Silber and Schiff Reagents as Spot Tests for Steroids applied on Paper and their (Dr Marion K Birmingham), B A 67
Application of Ultra-Violet Lights to Underwater Research (Richard G Woodbridge, III, and Dr Richard C Woodbridge), 259
Application of Warburg's Equation to Tissue Slices (Dr I S Longmuir and Dr Ann Bourke), 634
Applications Computer (Report of the Proceedings of the fifth Annual Symposium on), 771
Applications of Insecticides New Pests of Cocoa (*Theobroma cacao* L) in Ghana following (P F Entwistle, C G Johnson and E Dunn), 2040
Applications of Paper Chromatography to Systematics—Recombination of Parental Biochemical Components in a *Baptisia* Hybrid Population (Dr R E Alston and Dr B L Turner), 285
Applications of Statistics in Physics, *review* by Dr H Steeple, 664
Applications (Foliar), of its Salts on Apple Rôle of the Anion in Magnesium Uptake from (M Allen), 995
Applications (Tracer), for the Study of Organic Reactions (John G Burr, Jr), *review* by Dr A I Scott 1902
Applied Bacteriology, Society for Election of Officers, 683
Applied Chemistry (Pure and), International Union of Meeting of the Commission on Geochemistry, 1193
  Election of members of the Commission on Geochemistry, 1193
  Election of Prof C W Correns as president for 1960 of the Commission on Geochemistry, 1193
Applied Chemistry (Pure and), International Union of (Committee of the Analytical Chemistry Section) Nomenclature in Titrimetric Analysis, 1686
Applied Chemistry (Pure and), International Union of (Commission on Macromolecules) International Symposium on Macromolecules, 1689
Applied Chemistry (Pure and) International Union of (Deutsche Bunsen Gesellschaft fur Physikalische Chemie and the) Symposium on Thermodynamics, 1606
Applied Mathematics at Cardiff 591
'Applied' Mathematics Surveys in, *review* by D G Kendall, 214
Applied Mathematics and Theoretical Physics at Cambridge, 686
Applied Mechanics Theoretical and, (Indian Society of Theoretical and Applied Mechanics Fifth Congress on), 1192
Applied Mechanics (Theoretical and), Indian Society of Fifth Congress on Theoretical and Applied Mechanics, 1192
Applied Microscopy and Photomicrography (H M Malies), *review* by Dr S Bradbury, 1174
Applied Physics at Durham, 1022
Applied Polymer Science, Journal of, Vol I, No I, 784
Approach (A Molecular), to the Problem of Viscoelasticity (Prof Alfred H Nissan and H G Higgins), 1477
Approach (A New), to Carbon Gasification (J D Blackwood and F K McTaggart), 447
Approach (A New), to the Dating of the Dead Sea Scrolls (Prof D Burton, J B Poole and Dr R Reed), 533

Approach (A New), to Immunity, *review* by Dr J H Humphrey, 753
Approach (A New), to the Mechanism of Mutations (Prof Paul Mandel and Pierre Chambon), 1501
Approach (A New), to Schizophrenia (Dr Julius I Steinfeld), *review* by Prof Martin Roth, 487
Approach (A New), to Schizophrenia (Dr Julius I Steinfeld), *review* by Prof Martin Roth, 487
Aqueous Extracts of Excised Tomato Roots Nitrate Reduction by (C S Vaidyanathan and Prof H E Street), 531
Aqueous Polymer Phase Systems Counter-Current Distribution of Proteins in (Per-Ake Ålbertsson and Ed Jacques Nyns), 1465, *erratum*, 1688
Aqueous Systems Solid State Rheological Study of the Mechanism of Paraffin-Detergent Interactions in (F J Radd and L H Crowder), 443
  Strength Impairment Mechanism of Glass in (Frederick J Radd and Donald H Oertle), 976
Arabinose and some other Sugars Discrimination of Xylose from (B Drozdz), 1395
Arabis Mosaic Virus Rôle of a Dagger Nematode (*Xiphinema* sp) in Outbreaks of Plant Diseases caused by (Dr B D Harrison and Dr C H Cadman), 1624
Aragon de la Cruz, Dr F (MacEwan, Dr D M C , and) Phase Transitions in Interlamellar Films, 1859
Arai, Hideo, and others Microbiological Transformation of a Cardiac Aglycone, 469
Arai, Ken-ichi, and others Changes in Purine Nucleotides of Red Lateral Muscle of Rainbow Trout, 1415
Aramaki, Shiger, and Roy, Prof Rustum Revised Equilibrium Diagram for the System Al_2O_3-SiO_2, 631
Arbuscular Organs (Fungal) Production of, on Laboratory Media (G A Atkins), 1738
Archaeological Investigations (Preliminary), in the Sierra de Tamaulipas, Mexico (Dr Richard S MacNeish), 593
Archer, B L , and others Incorporation of DL-[2-^{14}C] Mevalonic Acid Lactone into Polyisoprene, 268, *erratum*, 772
Archer, Dr G T Release of Histamine from Rat Mast Cells by Blood treated with Dextran, 1151
Archer, Sylvia M , and others Culture of Algae and other Micro-organisms in Deuterium Oxide, 729
Architects, New Zealand Institute of (New Zealand Master Builders' Federation and the) Establishment of a Building Research Bureau, 235
Arcs (Low-Voltage) Emission of Relatively High-Energy Ions from (E R Harrison), 245
Arctic A Flora of the, *review* by R D Meikle, 1347
Arctic Flora Circumpolar (Dr Nicholas Polunin), *review* by R D Meikle, 1347
Arctic North America The Benthos of Soft Sea-bottom in (Dr D V Ellis), B A 79
Arenicola marina (L) Local Races in Lugworms (Dr A Ducan), 71
Argillite Haida Carvers in (Prof Marius Barbeau), 409
Arginase Inhibitor Uraemia and its Treatment by (Dhruba K Sen), 459
Arginine Vasotocin (Active Principles of the Neurohypophysis of Cold-blooded Vertebrates), (Panayotis G Katsoyannis and Prof Vincent du Vigneaud), 1465
Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates Pharmacological Evidence for the Presence of (Active Principles of the Neurohypophysis of Cold-blooded Vertebrates), (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464
Argonne National Laboratory Zero Gradient Synchrotron, 503
Argus, Prof Mary F , and Ray, Francis E Possible Relation between Carcinogenicity and Ease of Hydrolysis *in vitro* of Derivatives of 2-Aminofluorene, 2018
Arigoni, Dr D Steric Aspects of the Chemistry and Biochemistry of Natural Products (Steric Aspects of the Biosynthesis of Terpenes and Steroids), 947
Arimura, Akira, and Dingman, Prof Joseph F Specific and Sensitive Assay Method for Vasopressin and Oxytocin using Glass-Paper Chromatography, 1874
Armco Iron Dynamic and Static Deformation of (H P Tardif and P Chollet), 1917
Armitage, Dr P , and others Dose-Response Relationship in Radiation Leukaemia, 1669
Armstrong, D L Chemistry of Propellants (Characteristics of Liquid Propellants desired and achieved in Rocket Engines), 778
Armstrong, Brigadier, E F E Nature Conservation and Youth Service in Britain, 685
Armstrong, F A J Chemical Oceanography, *review*, 299
Armstrong, J J , and others Teichoic Acids from Bacterial Walls—Composition of Teichoic Acids from a Number of Bacterial Walls, 247 , Structure of Teichoic Acid from the Walls of *Bacillus subtilis*, 248
Arnold, Dr A H M Title of professor of electrical engineering in the University of London (at King's College) conferred on, 1535
Arnold, C A , and Lowther, J S Origin and Dispersal of Flowering Plants (Low Representation of Angiosperms in two American Cretaceous Floras), 1201
Arnon, Prof Daniel I Conversion of Light into Chemical Energy in Photosynthesis, 10, *errata*, 1613
Arnott, Dr Howard J Vein Anastomoses in the Leaves of Long Shoots of *Ginkgo biloba*, 1336
Aromatic Compounds Hydrogenolysis of Carbon-Oxygen Bonds in some, by Electrolysis (Dr P H Given and Dr M E Peover), 1064
Aromatic Hydrocarbons (Polycyclic) Effect of, on the Polarographic Maximum of Copper (C E Searle), 1716
Aromatic Ring Opening in the Presence of Oxygen in Irradiated Solutions (Israel Loeff and Gabriel Stein), 901
Aromatic Substitution—Nitration and Halogenation (Dr P B D de la Mare and J H Ridd), *review* by Prof M J S Dewar, 925
Arrangements (Dislocation), in Molybdenum (J F Kerridge, A A Johnson and H I Matthews), 356
Arrowsmith, J R Ergonomics, its Place in Industry, B A 21
Arsenic-resistant and Sensitive Strains of the Blue Tick, *Boophilus decoloratus* Contents of Cystine-Cysteine, Glutathione and Total Free Sulphydryl in (Dr J S Harington), 1739
Artemia (Genus) Occurrence of Neoteny in the (Inder Chand Baid), 73
Artemesia monospermia grown in Egypt *In vitro* Study of the Anthelminthic Property of (A Sharaf, Z F Ahmed and F Abdel Moneim), 647
Arterial Mucopolysaccharides (Human) Anticoagulant Activity of (Prof John E Kirk), 369
Arthrobacter Taxonomic Position of (Dr C S Cummins and Dr H Harris), 831
Arthur, Dr D R Appointed reader in zoology at King's College, London, 1613
Arthur (James) Lecture on the Evolution of the Human Brain—The Discrete and the Diffuse in Nervous Action (Prof D P C Lloyd), 1777
Artificial Organs—Biological Applications (Prof A Hemingway), B A 45
Artman, M (Bekierkunst, Dr A , and) Effect of Cell-Free Extracts from *Mycobacterium tuberculosis* $H_{37}Rv$ on Lung Succinooxidase, 458
Arts Help for the (Calouste Gulbenkian Foundation), 699
Arts and Sciences, American Academy of Election of New Fellows and Foreign Honorary Members, 409
  Re-election of Dr Kirtley F Mather as president, 410
Arvegwitch, Dr W I Photography in the International Geophysical Year (Photo-topographic Methods for the Study of Glaciers), 1032
Arylesterase of Human Serum Activation and Inhibition of the (Prof E G Erdos, C R Debay and M P Westerman), 430
Asahina, Eizo Prefreezing as a Method enabling Animals to survive Freezing at an Extremely Low Temperature, 1003
Asbestos Dust Concentrations Measurement of, with the Long-Running Thermal Precipitator (Dr C G Addingley and Dr R Gaze), 715
Ascaris lumbricoides Electrical Activity in the Muscle Cells of (Dr M Jarman), 1244
Ascites Carcinoma (Ehrlich) Effect of Chlorpromazine on Crocker Sarcoma and (Prof M Chorazy), 200
Ascites Tumour (Ehrlich) Ribonucleases of Mouse Tissues and of the (K A O Ellem, J S Colter and Jeanne Kuhn), 984
Ascites Tumour Cells (Intact) Efficiency of the Mitochondrial Oxidative Phosphorylations in (Dr P Emmelot and C J Bos), 2024
Ascites Tumour Cells (Mouse) Growth Inhibition of, by Powdered Tragacanth (Tragacanthae Pulvis, B P), (Dr E M F Roe), 1891
Ascoli, F , and others Influence of Counterion Association on the Configurational Stability of Deoxyribonucleic Acid in Solution, 1482
Ascorbic Acid Distribution of, in the Leaves of some Plants (Dr Philippe Hagene), 284
  Presence in Rose Hips of Substances Inhibiting the Oxidation of (Dr G A D Jackson and R B Wood), 902
Ascorbic Acid Biosynthesis Stimulatory Effect of Foreign Compounds on, and on Drug Metabolizing Enzymes (Dr A H Conney and Dr J J Burns), 363
Aseptic Conditions A Simplified Method for the Culture of *Blatella germanica* under (R B Clayton), 1166
Asexual Reproduction in the Enchytraeidae (Olig), (B Christensen), 1159
Ash (Worzel Deep-Sea) Origin of the (Edward Anders and Dr D Nelson Limber), 44
Ashby, Sir Eric Speaking at the Inaugural Meeting of the International Commission on Higher Education in Nigeria, 152
Ashes (Marine Biological) Some Activation Analyses of Six Trace Elements in (R Fukai and Prof W W Meinke), 815
Ashmore, Dr A Appointed to a senior lectureship in physics in the University of Liverpool, 410
  Appointed to the University of London readership in experimental physics at Queen Mary College, 595
Ashmore, Prof James, and others Liver Glucosyl Oligosaccharides and Glycogen—Carbon-14 Dioxide Experiments with Hydrocortisone, 1380
Ashton, Francis T A Method for the Quantitative Study of the Surface Precipitation Reaction, 1735
Ashton, G C β-Globulin Alleles in some Zebu Cattle, 1135
Ashwood-Smith, Dr M J , and others Radioprotective Action of Methoxiamine, 1729
Ashwood-Smith, Dr M J , and Smith, A D Rat Brain Glutathione and Pyridoxine Deficiency, 2028
Asia and the Far East School Meals in, 420
Asia (South and South-East) Bibliography of Scientific Publications of (Unesco Science Co-operation Office), Vol 5, No 6, 772
Asian Strains of Influenza Virus Serum Inhibitors of (Suzanne M James and Paul Fiset), 1656
Aspects of Analysis and Probability Some (Irving Kaplansky, Marshall Hall, Jr , Edwin Hewitt and Robert Fortet), *review* by D G Kendall, 214
Aspects of Magnetism Some (Institute of Physics Conference on), 322
Aspects of Solid State Physics, *review* by Prof E C Stoner, 1753
Aspects (Medical), of Complex Carbohydrates (Prof M Stacey), B A 42
Aspects (Mineralogical), of Soil Science (Welsh Soils Discussion Group Discussion on), 156
Aspects (Public Health), of Nuclear Energy Post-Graduate Training in the (World Health Organization, Technical Report Series No 154), 33
Aspects (Steric), of the Chemistry and Biochemistry of Natural Products (Biochemical Society Symposium on), 947
Aspergillus niger Effect of Sulphanilamide on Citric Acid Production by (K V Rajagopalar, R Radhakrishnamurthy and P S Sarma), 461
Aspirin and Algesimetry (Dr C V Winder), 494
Aspro-Nicholas, Ltd , Appointment of R Levin as development planning executive, 1192
Assay of Plasma Insulin in Human Subjects by Immunological Methods (Dr Rosalyn S Yalow and Dr Solomon A Berson), 1648
Assay of Respiratory Enzymes in Single Living Cells Localization and—Absorbancy Measurements on the *Nebenkern* (Dr Robert P Perry, Dr Bo Thorell, Dr Lennart Akerman and Prof Britton Chance), 929 , Fluorescence Measurements of Mitochondrial Pyridine Nucleotide in Aerobiosis and Anaerobiosis (Prof Britton Chance and Dr Bo Thorell), 931 , Absorbancy Measurements on Liver and Kidney Cells (Dr Bo Thorell and Prof Britton Chance), 934
Assay (Quantitative), of Compounds in Isolated, Fresh Nerve Cells and Glial Cells from Control and Stimulated Animals (Prof Holger Hyden), 433
Assay (Spectrophotofluorometric), of Griseofulvin (Carole Bedford, K J Child and E G Tomich), 364

- Assay Method (Specific and Sensitive), for Vasopressin and Oxytocin using Glass-Paper Chromatography (Akira Arimura and Prof Joseph F Dingman), 1874
- Assay Systems (Biochemical), involving Nitrite Estimation by Diazotization Measurement of Inhibition by Azide in (Dr E J Hewitt and D G Hallas), 1485
- Assay Systems (Biological) Interference by Azide with Diazotization Procedures used in (J R Villanueva), 549
- Assessment of the Phagocytic Activity of the Macrophage System (Prof D L J Bilbey and Dr H Salem), 992
- Assimilation (Nitrogen), of *Vicia villosa* Influence of Gibberellic Acid and Photoperiod on the Growth, Flowering, Nodulation and (the late Prof Margaretha G Mes), 2035
- Assistance for Under-developed Countries, 1363
- Associated with Noise Distribution of Flares on the Solar Disk (L R McNarry), 806
- Associated Electrical Industries, Ltd Inauguration of *Merlin* by H R H the Duke of Edinburgh, 1191
  - Sunvic Controls, Ltd , to combine with the Instrument and Meter, Scientific Apparatus and X-Ray Departments of Metropolitan-Vickers Electrical Co , Ltd , to form the Instrumentation Division of, 1535
- Association between Abo Blood Groups and Fertility in a Normal American Population (Dr T Edward Reed and Dr J H Ahronheim), 611
- Association between Colour of the Iris of the Eye and Reaction to Dental Pain (Dr Philip R N Sutton), 122
- Association of Radio Outbursts with Solar Flares (L D de Feiter, A D Fokker and J Roosen), 805
- Association (Counterion) Influence of, on the Configurational Stability of Deoxyribonucleic Acid in Solution (F Ascoli, C Botre, V Crescenzi, A Mele and Prof A M Liquori), 1482
- Astaxanthin Occurrence of, in the Flower Petals of *Adonis annua* L (A Seybold and Prof T W Goodwin), 1714
- Astbury, Dr N F Special Ceramics, 1115
  - Appointed director of the British Ceramic Research Association, 1843 , work of, 1843
- *Asthenes* (Aves, Furnariidae) von der Kuste und dem westlichen Andenabhang Sudperus Ein neuer (Maria Koepcke), (Beitrage zur Neotropischen Fauna), *review* by Dr F A Turk, 1177
- Aston, J G Thermodynamics (Phase Changes in Condensed Systems), 1609
- Astronautics Vistas in—First Annual Air Force Office of Scientific Research Astronautics Symposium (edited by Morton Alperin and Marvin Stern), *review* by D G King-Hele, 663
- Astronomers (Radio) International Conference of, *review* by Dr H P Palmer, 1755
- Astronomical Positions of Uranus Great Earthquakes and the (Prof A Tomaschek), 177
- Astronomical Society, Royal *Geophysical Journal*, Vol 2, No 1, 504
- Astronomische Gesellschaft Star Catalogues, 856
- Astronomy at Glasgow, 23
- Astronomy at St Andrews, 768
- Astronomy for the Layman, 1913
- Astronomy (Radio) Paris Symposium on, 1958 (edited by Ronald D Bracewell), *review* by Dr H P Palmer, 1755
- Astrophysics, *review* by Prof R O Redman, B A 3
- Astrophysik I, Sternoberflächen-Dopplesterne (Handbuch der Physik, herausgegeben von S Flugge, Band 50), *review* by Prof R O Redman, B A 3
- Asymmetric Recombination Properties and Inheritance of Haemoglobin by (Dr Harvey A Itano and Elizabeth Robinson), 1468
- Asymmetrical Delivery in Rabbits (Dr Luiz Macedo Costa and Dr Arpad Csapo), 144
- Asymmetry of the Crystalline Electric Field in Cobalt Acetate Tetrahydrate Temperature Variation of the Principal Magnetic Moments of Co^{++} Ions and the (Dr Bhagawati Charan Guha), 50
- Asymmetry (Possible), in the Daily Range of the Geomagnetic Vertical Intensity around the Magnetic Equator (Dr C A. Onwumechilli), 51
- Atherogenic Action of Excess Hydrocortisone Mechanism of the (Dr Henry Grossfeld), 38
- Atkins, G A Production of Fungal Arbuscular Organs on Laboratory Media, 1738
- Atkins, Dr W R G Plants on Land and in the Oceans (Presidential Address to Section K (Botany) of the British Association for the Advancement of Science), B A 46
- Atkinson, J C , and others Action of Mixed Solvents on Wool, 444
- Atkinson, Dr M R , and others Equilibrium Constant of the Galactokinase Reaction and Free Energy of Hydrolysis of Adenosine Triphosphate, 1925
- Atlantic Hydromedusae, *review* by J H Fraser, 300
- Atlantic Ocean and adjacent Waters The Hydromedusae of the (P L Kramp, (*Dana* Report No 46), *review* by J H Fraser, 300
- Atlantic Ocean (North) Polar Front Survey in the, 1180
- Atlantic Salmon Sodium Regulation in the Blood of Parr and Smolt Stages of the (Prof H J Koch, J C Evans and E Bergstrom), 283
- Atlantic-European Area Changes in the Climate of, and Secular Solar Activity (Z Gregor and L Křivsky), 682
- Atmosphere (Outer) Directional Observations of Radio Noise from the (G R A Ellis and D G Cartwright), 1307
  - Spaced Observations of Radio Noise from the (G R A Ellis, D G Cartwright and J R V Groves), 1391
- Atmosphere (Upper) Air Density in the, from Satellite Orbit Observations (Dr G V Groves), 178
  - Density of the, from Analysis of Satellite Orbits—Further Results (D G King-Hele), 1267
- Atmosphere (Upper) Density Variations due to Hydromagnetic Heating (Dr A J Dessler), 261
- Atmospheric Moisture Absorption of, by Freeze-dried Pork and Fish (Norman A Matheson), 1949
- Atmospheric Sciences Advisory Panel on (United States National Science Foundation), 1022
- Atmospheric Water Vapour Pressure World Distribution of (G A Tunnell), B A 15
- Atmospherics Very Low-Frequency Spectra of, propagated through the Ionosphere (Tatsuzo Obayashi), 34
- Atom Pioneer Research on the—the Life Story of Frederick Soddy (Muriel Howorth), *review* by Prof Norman Feather, 298
- Atom Recombination Mechanism of (Prof G Porter and Dr J A Smith), 446
- Atom (Halogen) Influence of the Size of the, on the Difference between Lattice Constants of Copper dipyridine dichloride and dibromide (Vladimir Kupcik and Slavomil Durovic), 1060
- Atomenergi, Norwegian Institutt for The Halden Reactor, 516, 1844
- Atomic Absorption Spectroscopy Determination of Magnesium in Blood Serum by (Dr J B Willis), 186
- Atomic Energy The Release and Use of (Dr T E Allibone), 1613
- Atomic Energy in Australia, 593
- Atomic Energy in Industry (National Industrial Conference Board, Inc , seventh Annual Conference on), 506
- Atomic Energy Agency (International) Directory of Nuclear Reactors, Vol 1, Power Reactors, *review* by Dr A J Salmon, 1438
- Atomic Energy Agency (International), and the International Council of Scientific Unions Symposium on Radioactivation Analysis, 951
- Atomic Energy Agency (International), (Unesco and the) Appeal for help to reconstruct the Library of the Brazilian Centre for Physics Research, 769
- Atomic Energy Agency (International), and others Symposium on the Biological Effects of Low Doses of Ionizing Radiations, 1111
  - Course on the Use of Radioisotopes in Agricultural Research, 1451
- Atomic Energy Authority (United Kingdom) The Proton Linear Accelerator at the Rutherford High Energy Laboratory, 94
  - The *Nimrod* 7,000-MeV Proton Synchrotron, B A 14
  - The Tandem Generators of the (K W Allen and F A Julian, W D Allen and A E Pyrah, and J Blears), 303
  - Fifth Annual Report (1958-59), 602
  - *Zenith* Reactor at Winfrith Heath, 680
  - Special Promotions, 858
  - Grant not exceeding £5,700 to the University of Oxford, for studies in interferometric spectroscopy, and a further grant not exceeding £1,250, for work on the constitution of bismuth-rich alloys, 943, 1273
  - Thermonuclear Programme, 1106
  - To purchase a Neutron Source Thermal Reactor (*Nestor*) from the Hawker Siddeley Nuclear Power Co , 1533
  - Grant of £8,500 to the University of Oxford, for a study of polarized nuclear systems using resonance techniques, 1535
  - A Record of the Proceedings of the Symposium on Glove Box Design and Operation held in the Cockcroft Hall, A E R E , 1957 (Glove Boxes and Shielded Cells for Handling Radioactive Materials, edited by G N Walton), *review*, 1599
- Atomic Energy Authority (United Kingdom), (United States Atomic Energy Commission and the) To exchange Technical Information of Advanced Gas-cooled Reactors, 1361
- Atomic Energy Commission (Australian) Research Grants, 940
  - Sixth Annual Report (1957-58), 1118
- Atomic Energy Commission (Danish) Report for 1957-58, 517
- Atomic Energy Commission (United States) Hot Laboratory Equipment, new edition, 155
  - Technical Books sponsored by the, 407
  - Course on the Basic Techniques of Handling Radioisotopes, 771
  - Amendments to the Atomic Energy Act of 1954, 853
  - Report ORINS-25, The Acute Radiation Syndrome—a Medical Report on the Y-12 Accident, 1958 (compiled by Dr Marshall Brucer), 1022
- Atomic Energy Commission (United States), and the United Kingdom Atomic Energy Authority To exchange Technical Information on Advanced Gas-cooled Reactors, 1361
- Atomic Energy Research Establishment Reactor School Courses, 942
  - Third Reactor School Course on the Control and Instrumentation of Reactors, 1026
- *Atomic Energy Review*, Vol 2, No 1 (General Electric Company), 407
- Atomic Hydrogen (Neutral), in Globular Clusters A Search for (Dr Morton S Roberts), 1555
- Atomic Mechanisms of Fracture (United States National Academy of Sciences—National Research Council, Conference on), 324
- Atomic Merchant Ship First, B A 15
- Atomic Motions (Molecular and), in Liquids and Solids by Radiofrequency Methods (Colloque AMPERE and the Radiofrequency Spectroscopy Group Joint Discussion on), 157
- Atomic Power From Man Power to (Victor Wall), 1535
- Atomic Power Constructions, Ltd Research and Development at the Heston Laboratories, 517
- Atomic Spectra Collision Effects in (W R Hindmarsh), 155
- Atomic Tests Effect of, on Radio Noise (C A Samson), 538
- Atomic Units (Prof H Shull and Dr G G Hall), 1559
- Atomic Weight of Silver (E A C Crouch, E R Preece, I G Swainbank and A H Turnbull), 358
- Atoms From Axes to, *review* by Dr A R Hall, 921
- Atoms (Adjacent), in some Aliphatic Carbonyl Compounds A Correlation between the Shift in the Ultra-Violet Absorption Maxima and the Electronegativity of the (Dr P Borrell), 1932
- Atrophic Muscle Fibres Dissociation of the 'Surface Membrane Complex' in (Dr R Birks, Prof B Katz and Dr R Miledi), 1507
- Attempt at Calculating the Taft's Constants σ^* (Rudolf Zahradník), 1865
- Attempts to Modify the Normal Metabolism of Strontium-90 in Rats (Dr V Volf), 1401
- Attention and Consciousness Perception, (Prof Magdalen D Vernon), B A 45
- Attenuated Strain of Canine Distemper Virus in Tissue Culture (Prof. Gunnar Rockborn, 822
- Attlee, Earl Presidential Address to the Annual Conference of the Library Association, 1455
- Attractant (Common), for the Tobacco Hornworm, *Protoparce sexta* (Johan) and the Colorado Potato Beetle, *Leptinotarsa decemlineata* (Say), (Dr Robert T Yamamoto and Prof G Fraenkel), 206
- Attree, V H Electronics Exhibition, 1277
- Atypical Epithelioma of Rat Occurrence of Polynucleotide Phosphorylase in (Dr Kunio Yagi, Takayuki Ozawa and Hiroshi Konogi), 1939
- Audubert, Rene, and de Mende, Serge The Principles of Electrophoresis (translated by A J Pomerans), *review* by Dr R Consden, 84
- Audus, Prof L J Plant Growth Substances, second edition, *review* by Prof R L Wain, 925
- Aull, jun , A C , and others Relation of Ethanol Metabolism to Several Factors in the Rat, 1721

Aureomycin Effective Increase in Nematode Populations by the Addition of (C O R Everard and William A Feder), 1887
Aurora Low-Frequency (100 kc /s) Radio Noise from the (R L Dowden), 803
  Colour Photography of the (B P Sandford and P Heiser), 540
Aurora and Geomagnetic Disturbance Diurnal Variation of, at New Zealand Antarctic Stations (Dr T Hatherton and G G Midwinter), 889
Aurora, the Radiation Belt and the Solar Wind—a Unifying Hypothesis (M H Rees and G C Reid), 539
Auroral Frequency Lines (Dr J M Stagg), 262 , (Dr Bengt Hultqvist), 263
Auroral Zone (Inner) Existence of an (Dr Knud Lassen), 1375
Austad, Rolv, and Garm, Dr Otto Periodic Acid-Schiff-Positive Material and Alkaline Phosphatase in the Uterine Wall of the Pig during the Sexual Cycle, 999
Austen, Dr A E W , and Priede, Dr D Recent Studies of Noise Problems (Physical Acoustics—Diesel Engine Noise), 415
Austenitic Stainless Steel Chromium Distribution around Grain Boundary Carbides found in (B E Hopkinson and K G Carroll), 1479
Austern, Prof N Nuclear Forces and the Few-Nucleon Problem (Preliminary Calculations concerning the Structure of ^{6}Li and ^{12}C), 1114
Austin, E R Modern Network Theory in Electrical Engineering (Design and Construction of Filter Networks), 1692
Australia Atomic Energy in, 593
  Fencing Posts in (Commonwealth Scientific and Industrial Research Organization, Australia, Rural Research, 27), 321
  New Fossil Penguin from (G G Simpson), 1612
  Nuclear Research in, 1118
  Radiation Observations with Satellite 1958δ over (Dr A J Herz), Dr K W Ogilvie and J Olley, and R B White), 391
  Sporidesmium bakeri recorded from Victoria (B S Janes), 1327
Australia (South-western) Precambrian Geology of (A F Wilson), 237
Australian Academy of Science New Building of the, B A 10
  Selby Fellowship, 684
Australian Atomic Energy Commission Research Grants, 940
  Sixth Annual Report (1957-58), 1118
Australian Botanical Laboratory New, 1776
Australian Chemical Institute, Royal Election of C E C Nicholls as president, 1106
Australian Commonwealth Scientific and Industrial Research Organization
  Grant of 30,000 dollars from the Rockefeller Foundation, for special equipment for the new Division of Tropical Pastures, 93
  Grant of 100,000 dollars from the Rockefeller Foundation, for the Divisions of Plant Industry and of Entomology, 93
  Grant of 250,000 dollars from the Rockefeller Foundation, towards the cost of the radio telescope for the Division of Radiophysics, 93
  Formation of a Division of Mineral Chemistry, 237
  Appointment of Dr F W G White as chairman, 317
  Appointment of Dr R N Robertson as a full-time member of the Executive, 317
  Rural Research in C S I R O , 27, Fencing Posts in Australia, 321
  List of Divisions and Sections, 410
  Tenth Annual Report (1957-58), 1027
  Second Australian Spectroscopy Conference, 1195
  Symposium on the Structure and Chemistry of Proteins, 1276
  Retirement of D A Gill as chief of the Division of Animal Health and Production, 1532
  Appointment of Dr J M Rendel as chief of the Division of Animal Genetics, 1532
  Appointment of Dr T S Gregory as chief of the Division of Animal Health, 1532
  Appointment of Dr I W McDonald as chief of the Division of Animal Physiology, 1532
  Cunningham Laboratory of the, 1776
  Appointment of C S Christian and Prof L G H Huxley as members of the Executive, 1984
  Appointment of G B Gresford as secretary, 1985
  Appointment of W Ives as executive officer, 1985
Australian Defence Standards Laboratories Technical Memorandum 2, The Intensity of Infra-red Absorption Bands—a Bibliography (compiled by Dr R G Gillis), 682
  Annual Report for 1956-57, 782
Australian Environment Strontium-90 in the, 1957-58 (Dr F J Bryant, L J Dwyer, Dr J H Martin and Prof E W Titterton), 755
Australian Journal of Statistics (Statistical Society of New South Wales,) 504
Australian Mammal Society Inaugural Meeting, B A 16
Australian Museum Annual Report for 1957-58, 592
Australian Nuclear Research Foundation Third Summer School for Science Teachers, 1108
Australian Prehistory Dating of (D J Mulvaney), 918
Australian Scientific Research Development Trends in, 1027
Australian Spectroscopy Conference Second (Dr Norman S Ham), 1195
Authors Notes for (Institute of Physics), revised edition 95
Authors of the Reports of the United States Geological Survey Suggestions to, fifth edition, *review* by Prof C F Davidson, 390
Authors (Forty-seven), in Search of a Conclusion, *review* by N W Pirie, 920
Auto-Antibody (Agglutinating), (Panagglutinin) Production of an, Active upon Tanned Erythrocytes in the Rabbit (P O Hubinont, P Ghysdael and O Thys), 1250
Auto-Intoxication après Brûlure (R Godfraind), *review* by Dr S Sevitt, 5
Automatic Control, International Federation of Members of the Executive Council, 1450
Automation and Society (edited by Howard Boone Jacobson and Joseph S Roucek), *review* by R Brightman, 1438
Automobile Collisions Experiments on (Prof J H Mathewson), 237
Autoradiographed Radioactive Particles Electron Microscopy of (L A George, II , and G S Vogt), 1474
Autoradiography of Neutron-activated Sections Distribution of Sodium in Compact Bone, as revealed by (Prof J Vincent), 1332
Autoradiography of Tritium-labelled Compounds on Paper Chromatograms (Dr A W Rogers), 721
Autoradiography (Low-Temperature), for the Detection of Tritium in Tissue, with Removal of Luminescence induced by Tritium (P Pellerin, P Fallot, M Laine-Boszormenyi and F Serrel), 1385
Autoregulation of Renal Blood Flow Mechanism of (Dr Allen M Scher), 1322
l'Autosterilite du Cafeier robusta (*Coffee canephora* Pierre) , Recherchés sur (M Devreux, G Vallaeys, P Pochet et A Gilles), 518
Autumn Extended Dormancy of Deciduous Woody Plants treated in, with Gibberellic Acid (Dr P W Brian, J H P Petty and P T Richmond), 69
Auxin and the Bulbing of Onions (Dr J E Clark and Prof O V S Heath), 345
Auxin and Gibberellic Acid Effects of, on Growth of *Ulothrix* (Dr Herbert Conrad, Dr Paul Saltman and Dr Richard Eppley), 556
Availability of Plant Nutrients (British Society of Soil Science Discussion on) 159
Avena Electrical Determination of Transport of 3-Indole Acetic Acid in (I A Newman), 1728
Averbach, B L , and others Atomic Mechanisms of Fracture (Tensile Fracture of Mild Steels), 325
Avian Brood Parasitism Prolactin in the Cowbird's Pituitary in relation to (Prof E O Hohn), 2030
Aviation, Ministry of Grant of £1,395 to the University of Oxford, for research on the mechanism of operation of the cryotron, 1535
  Promotion of Dr C H Johnson to chief scientific officer and appointment as director of the Explosives Research and Development Establishment, Waltham Abbey, 1448, 1775
  Promotion of W H Hill to deputy chief scientific officer and appointment as deputy director of Air Armament Research, 1448 , 1775
  Promotion of S A Hunwicks to deputy chief scientific officer and appointment as director of Atomic Weapons (Development), 1775
  Promotion of A N Christmas to deputy chief scientific officer and appointment as director of Guided Weapons (Technique), 1775
Avoidance Response , Effect of a Signal Contingent upon an (Prof J D Keehn and Sanniyah Nakkash), 566
Awards for Study in Statistics (University of Chicago), 772
Axelrad, Dr A A , and others Chromosome Complement of Spontaneous Leukaemia in *AKR* Mice, 998
Axelrod, D I Origin and Dispersal of Flowering Plants (Modern Distribution Patterns), 1200
Axelrod, Dr Julius, and Tomchik, Dr Robert Activation and Inhibition of Adrenaline Metabolism, 2027
Axes to Atoms From, *review* by Dr A R Hall, 921
Axford, W A (compiled by) Handicapped Children in Britain—their Problems and Education (Library Association), 1777
Axiomatic Set Theory (Prof Paul Bernays), *review* by Dr L S Goddard, 1178
Axoplasm (Nerve) Action of Ribonuclease on, as Demonstrated by Silver Staining (R K Winkelmann and Robert W Schmit), 553
Aylward, Dr Francis, and Nichols, B W Sterol Glycosides in Oilseed Phospholipids, 1319
Ayres, P J Biosynthesis and Secretion of Adrenocortical Steroids (Relation of Steroid Secretion to the Histological Zones of the Adrenal Cortex), 416
8-Azaguanine Inhibition of Haemoglobin Synthesis in De-embryonated Chick Blastoderm (B R A O'Brien), 376
Azaroff, Prof Leonid V , and Buerger, Prof Martin J The Powder Method in X-Ray Crystallography, review by Prof H Lipson, 1599
Azide Interference by, with Diazotization Procedures used in Biological Assay Systems (J R Villanueva), 549
  Measurement of Inhibition by, in Biochemical Assay Systems involving Nitrite Estimation by Diazotization (Dr E J Hewitt and D. G Hallas), 1485
Azotobacter vinelandii Fractionation of the System bringing about Oxidative Phosphorylation in (H G Hovenkamp), 471
  A Function for the Extracellular Polysaccharide of (Dr Michael H Proctor), 1934
  A Non-Gummy Chromogenic Strain of (J A Bush and Prof P W Wilson), 381
Azuma, Prof Ryotaro Work in connexion with the 1964 Olympia Games, B A 14
Azuma, R E Appointed a lecturer in experimental and theoretical physics at the University of Glasgow, 1915

BAAR, S Hydrolysis of Heated' Haemoglobin, 986
Babad, J , and others Lowered Bactericidal Efficiency of Hydrogen Peroxide on Milk from Cows treated with Penicillin, 292
Babcock, Dr Horace W , and others Magnetic Field associated with a Great Solar Flare, 351
Bacharach, A. L Science Writing, *review*, 1749
Bachhawat, Dr B K Purification of Enzymes, 1368
Bachhawat, Dr B K (Pattabhiraman, T N , and) Biochemical Research in India (Purification and Properties of Glutamic-Oxalacetic Transaminase from Ox Brain and from Human Brain), 1368
Bacila, Metry, and Villela, Dr Gilberto G A Rapid and Sensitive Method for the Determination of Xanthine Oxidase Activity using the Oxygen Electrode, 1394
Bacila, Metry (Medina, Heitor and) Reversal by Acetylcholine of the Inhibition by Thyroxine of Oxidative Phosphorylation in Guinea Pig Heart Sarcosomes, 1066
Bacilli (Acid-fast) Difference between the Catalases of (Wieslaw Tysarowski and Stanislaw Kwiek), 1513
Bacilli (Bovine Type Tubercle) Nicotinamidase in *Mycobacteria*—a Method for Distinguishing, from other *Mycobacteria* (Dr Kiyoshi Konno, Dr Hideo Nagayama and Dr Sutemi Oka), 1743
Bacillus coagulans var *thermoacidurans* Rôle of the Glycolytic Enzyme System in the Germination of Spores of (Prof Mikio Amaha and Tomoko Nakahara), 1255
Bacillus licheniformis Antibiotic Production as a Function of Spore Formation in (Robert W Bernlohr and G D Novelli), 1256
Bacillus subtilis Anomalous Genetic Interactions observed in (M Kohiyama and Y Ikeda), 208
  Incorporation of 5-Bromouracil into Transforming Principle of, and its Biological Effects (Dr Erela Ephrati-Elizur and Prof Stephen Zamenhof), 472
  Structure of Teichoic Acid from the Walls of (Teichoic Acids from Bacterial Walls), (J J Armstrong, Prof J Baddiley and Dr J G Buchanan), 248

Bacillus Calmette-Guérin Infection Effect of, on Transplanted Tumours in the Mouse (Dr Lloyd J Old, Dr Donald A Clarke and Dr Baruj Benacerraf), 291
Backeberg, Curt Die Cactaceae, Band 1, Einleitung und Beschreibung der Peireskioideae und Opuntioideae , Band 2, Cereoideae (Hylocereae—Cereae, Austrocereinae), *review* by N Y Sandwith, 1010
Backer, Prof H J *Obituary* by Prof Frederick Challenger, 1187
Background The Scientific (Prof A Norman Jeffares and M Bryn Davies), *review* by Dr W L Sumner, 5
Background Gamma-Radiation in Leeds during 1955-59 Some Measurements of (Prof F W Spiers), 1680
Background (Pre-historic), of Indian Culture (Colonel D H Gordon), *review* by M C Burkitt, 131
Backofen, W A Atomic Mechanisms of Fracture (Effect of Crystal Orientation on Liability to Fracture), 325
Bacon, Dr G E Promoted to Deputy Chief Scientific Officer in the Scientific Civil Service, 858 , work of, 858
Bacon, Dr J S D Carbohydrates of the Rampion, *Campanula rapunculus* L , 1957
Bacon, Dr R G R Oxidation of Organic Compounds (Oxidations by Persulphates), 327
Bacteria *Fasciculus limpidus* nov gen , nov spec , a Representative of a New Group of (Prof E G Pringsheim), 1098
  Mutation of, at High Levels of Survival, by Ethyl Methane Sulphonate (Anthony Loveless and Sheila Howarth), 1780
  Production of Colicine by Single (H Ozeki, Dr B A D Stocker and Helène de Margerie), 337
Bacteria (Gram-Positive) Characters associated with Parasitism in (Dr K A Bisset), B A 29
Bacteria (Industrial), National Collection of Transferred from the National Chemical Laboratory to the Torry Research Station, 1192
Bacteria (Non-Photosynthetic) Function of Carotenoid Pigments in (Micheline M Mathews and W R Sistrom), 1892
Bacteria (Photosynthetic) Function of Carotenoids in (Prof M Dworkin), 1891
Bacteria (Red Sulphur) Amino-Acids of (H Mukherjee), 1742
Bacterial Cell Affinity of Lysozyme to Structural Elements of the, as studied with Enzyme Labelled with Radioactive Iodine (Prof C Weibull, B Zacharias and H Beckman), 1744
Bacterial Cells utilizing Hydrocarbons for Growth Incorporation of Molecular Oxygen in (E R Leadbetter and J W Foster), 1428
Bacterial Flagellar Protein ε-N-Methyllysine in (R P Ambler and M W Rees), 56
Bacterial Recovery from Ultra-violet Light Macromolecular Synthesis in (C O Doudney), 189
Bacterial Ribonucleic Acid Massive Incorporation of 5-Fluorouracil into a (Dr Jack Horowitz and Prof Erwin Chargaff), 1213
Bacterial Walls Composition of Teichoic Acids from a Number of (Teichoic Acids from Bacterial Walls), (J J Armstrong, Prof J Baddiley, Dr J G Buchanan, A L Davison, M V Kelemen and F C Neuhaus), 247
  Teichoic Acids from—Composition of Teichoic Acids from a Number of Bacterial Walls (J J Armstrong, Prof J Baddiley, Dr J G Buchanan, A L Davison, M V Kelemen and F C Neuhaus), 247 , Structure of Teichoic Acid from the Walls of *Bacillus subtilis* (J J Armstrong, Prof J Baddiley and Dr J G Buchanan), 243
Bactericidal Efficiency (Lowered), of Hydrogen Peroxide on Milk from Cows treated with Penicillin (J Babad, D L Boros and F Baier), 292
Bacteriochlorophyll in *Chromatium* Influence of Carotenoids on the Infra-Red Spectrum of (Dr J A Bergeron and Dr R C Fuller), 1340
Bacteriology (Applied), Society for Election of Officers, 683
Bacteriophage Typing applied to Strains of *Brucella* Organisms (Prof G C van Drimmelen), 1079
Bacteriophages (*T*5 and *T*7) Effect of Deuterium Oxide on the Synthesis of (E L Rothstein, L A Manson, R Hartzell, jun , and David Kritchevsky), 1167
Bacteriophages (Some New Specific), for Plant Pathogenic *Xanthomonas* spp (Z Klement), 1248
Bacterium A New Nitrogen-fixing (H L Jensen, P K De and Roma Bhattacharya), 1743
Bacterium coli and *Staphylococcus albus* Growth of in Heavy Water (Elizabeth van Horn and Dr G C Ware), 833
Baddiley, Prof J , and others Teichoic Acids from Bacterial Walls—Composition of Teichoic Acids from a Number of Bacterial Walls, 247 , Structure of Teichoic Acid from the Walls of *Bacillus subtilis*, 248
Bade, E , and others Coal Science (Carbonization—Studies of the Maceral Species Exinite and Vitrinite by Pyrolysis under High Vacuum), 413
Bader, A M , and others Distribution of Nucleic Acids among Different Stable *L* Forms of *Proteus P* 18, 566
Badger, G M , and others (C F H Allen, in collaboration with) Six-Membered Heterocyclic Nitrgoen Compounds with Three Condensed Rings, *review* by Dr F G Mann, 216
Baekeland Memorial Lecture (Prof H Mark), 156
Baer, Prof Jean Evolution of Host—Parasite Relationships, 760
Baez, Prof S Flow Properties of Biological Systems (Pressure Effects in Living Microscopic Vessels), 1540
Baglioni, Corrado Genetic Control of Tryptophan Peroxidase-Oxidase in *Drosophila melanogaster*, 1084
Bagnall, Dr K W Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 859 , work of, 859
Baid, Inder Chand Occurrence of Neoteny in the Genus *Artemia*, 73
Baier, F , and others Lowered Bactericidal Efficiency of Hydrogen Peroxide on Milk from Cows treated with Penicillin, 292
Bailey, R W , and Bourne, Prof E J Formation of Leucrose in Dextran-producing Cultures of *Streptococcus bovis*, 904
Bailey, Prof V A The Steady-Rate Universe and the Deduction of Continual Creation of Matter, 537
Baker, C J W Special Ceramics (Construction and Advantage of various types of Carbon-tube Furnace), 1116
Baker, Faith A , and others Distribution of 5-Carboxymethylhydantoinase, 1314
Baker, Dr G , and others Cause of Wear in Sheeps' Teeth, 1583
Baker, Dr J R Recording the Positions of Microscopical Objects, 34
Baker, R G Elected president for 1960-61 of the Institution of Mining Engineers, 1845
Balakshin, Dr L Polar Front Survey (Hydrography—Sill Depth between the Greenland Sea and the Arctic Ocean), 1181
Balance in British Farming (Dr H G Sanders), B A 48
Balassy, J , and others A Method for *in vitro* Investigation of the Colloid-storing Function of Histiocytes, 1070
Balchin, Prof W G V A Water-Use Survey, 97
  Water Supply and Demand in Great Britain, B A 18
Ball, Dr J N , and Cowen, Prof P N Urethane as a Carcinogen and as an Anaesthetic for Fishes, 370
Balls, Dr W Lawrence *Obituary* of Dr D S Gracie, 315
Bamford, C H Macromolecules (Synthetic Polypeptides), 1690
Banana Detection and Identification of the Polyphenoloxidase Substrate of the (Dr L A Griffiths), 58
Banana Strains (Tomato and), of *Pseudomonas solanacearum* Comparison of Slime from (Dr W F Dudman), 1969
Banderschnecken Die, eine Studie zur Evolution der Tiere (Prof Dr F A Schilder und Dr Maria Schilder), *review* by Dr A J Cain, 390
Bandurski, Robert S , and others A Partial Chemical Characterization of Maize Coleoptile Cell Walls prepared with the Aid of a Continually Renewable Filter, B A 81
Banerjee, Prof Nikunja Vihari Concerning Human Understanding, *review* by Dr D J McCracken, 1571
Banff National Park, Alberta Mammals of (A W Banfield), 594
Banfield, A W Mammals of Banff National Park, Alberta, 594
Banhawy, M (Moussa, Dr Tohamy A , and) Effect of Insecticides on the Bodies of Nissl and Neurofibrillae of the Locust, *Schistocerca gregaria*, 915
Banks, A , and others Preparation of Crystalline *trans-trans* Methyl Linoleate Hydroperoxide, 816
Banks, Sir Joseph Some Eighteenth Century Birds Paintings in the Library of (1743-1820), (Averil Lysaght), 941
Banks The North Kenya (Dr J F C Morgans), 259
Bannikov, A G The Mongolian Wild Horse, *Equus przewalskii*, 1024
Baptisia Hybrid Population Applications of Paper Chromatography to Systematics—Recombination of Parental Biochemical Components in a (Dr R E Alston and Dr B L Turner), 285
Bar-Hillel, Prof Yehoshua (Fraenkel, Prof Abraham A , and) Foundations of Set Theory, *review* by Dr L S Goddard, 1178
Barakat, S E Y (Jackson, Dr G A D , and) The Organic Acids in Rose Hips, 1953
Barbeau, Prof Marius Haida Carvers in Argillite, 409
Barber, Prof H N , and others Transport of Driftwood from South America to Tasmania and Macquarie Island, 203
Barber, Dr Mary Biological Problems arising from the Control of Pests and Diseases (Drug-resistance in Bacteria), 1102
Barbier, Dr M , and others Isolation of 24-Methylene-cholesterol from Honey Bees (*Apis mellifica* L), 732
Barclay-Smith, P Oil in Navigable Waters, 949
Bardeen, Prof J Transistors and Associated Semiconductor Devices, 693
Bardsey Bird and Field Observatory Annual Report for 1957, 236
Barit, Dr T Y Nuclear Forces and the Few-Nucleon Problem (*p*-T Scattering and Allied Reactions), 1114
Barium (Radioactive), in Eye Tissues Distribution of (R J Garner), 733
Barium Titanate Adhesion (Ultrasonic), and Paste Transducers (Dr A Lutsch), 1458
Barker, A , and others Jets and Rockets, *review* by D G King-Hele, 1346
Barker, Dr G R Steric Aspects of the Chemistry and Biochemistry of Natural Products (Enzymes of Nucleotide Metabolism), 949
Barker, Harold Radiocarbon Dating, 672
Barker, Dr S A , and others Some Observations on certain Mucoproteins containing Neuraminic Acid, B A 68
  Biological Origin and Configuration of 10-Hydroxy-Δ^2-decenoic Acid, 634
  N-Methylation of Methyl 2-Acetamido-2-Deoxy-*α*-D-Glucopyranoside, 1718
Barley Photosynthesis in the Ear of (Prof A Frey-Wyssling and Dr M S Buttrose), 2031
Bar ing, E M Staff in Industry and Commerce—Management of Workers whose Skills are mainly Mental or Social rather than Manual, 319
Barlow, A J E , and others Effect of Steroids and related Compounds on the Growth of Dermatophytes, 1731
Barlow, Lady At the Annual Conference of the Library Association (Charles Darwin as Author), 1455
Barlow, Dr H B , and Donaldson, P E K Awarded a grant of £1,000 by the Paul Instrument Fund Committee of the Royal Society, 507
Barlow, Dr R B Steric Aspects of the Chemistry and Biochemistry of Natural Products (Steric Aspects of Drug Action), 948
Barnard, D , and others Incorporation of DL-[2-^{14}C] Mevalonic Acid Lactone into Polyisoprene, 268, *erratum*, 772
Barnell, Dr H R Appointed chief scientific adviser (food) to the Ministry of Agriculture, Fisheries and Food, 503 , work of, 503
Barnes, Barbara G A Dense Laminar Structure found in Conjunction with Cell Membranes in the Anterior Pituitary Gland, 651
Barnes, D W Awarded a Senior Studentship by the Royal Commission for the Exhibition of 1851, 409
Barnes, Dr H Apparatus and Methods of Oceanography, Part 1, Chemical, *review* by F A J Armstrong, 299
Barnes, Dr Richard H Appointed editor of the *Journal of Nutrition*, 156
Barnes, Robert L Formation of Allantoin and Allantoic Acid from Adenine in Leaves of *Acer saccharinum* L , 1944
Barnett, H A R Personnel Management and Technological Change (Government Policy and Company Pension Schemes for Manual Workers), 1614
Barnicot, Dr N A , and others Haptoglobin and Transferrin Variants in Bushmen and some other South African Peoples, 2042
Barrass, Dr Robert *Haematopota insidiatrix* Austen (Diptera, Tabanidae) in Southern Rhodesia, 739
Barratt, A S D Resignation from the Board of Edwards High Vacuum, Ltd , 1451
Barrer, Prof R M Gas Chromatography, 328
Barrere, M , and Français, G Chemistry of Propellants (Air-Burning Fuels—Properties and Preparation of Ramjet Fuels), 779
Barrett, J , and Clezy, P Selective Oxidation of Tetrapyrrole Side-Chains, 1988

Barrett, J F Appointed De Havilland Research Fellow in aeronautical engineering in the University of Southampton, 1915
Barron, D A Appointed a deputy engineer-in-chief in the General Post Office, 1531 , work of, 1532
Barry, J M , and O'Rourke, Prof Fergus J Species Specificity of Fish Mucus, 2039
Barry, T I , and Roberts, R Effect of Gamma-Radiation on the Synthesis of Methanol over Zinc Oxide, 1061
Barth, H (Brill, Prof R , and) Intensity of the (III) Reflexion for Diamond, 264
Bartlett, Sir Frederic Ergonomics, its Place in Industry, B A 20
Bartlett, Prof M S Fluctuation Phenomena and Stochastic Processes (Statistical Fluctuations which occur in Physics), 509
Bartley, W (Getz , G S , and) A Cardiolipin-like Compound in Rat Liver Mitochondria, 1229
Bartley, Dr W , and others Alkali Ion Determinations by means of Glass Electrodes (Tests on Experimental Electrodes of Aluminosilicate Glasses), 1617
Barton, D E , and Mallows, C L Estimation of Linear and Non-Linear Structural Relations, 1086
Barton, J C Fluctuation Phenomena and Stochastic Processes (Experimental Method of Simulating a One-dimensional Random Walk), 510
Barton, Dr J W Appointed lecturer in organic chemistry at the University of Bristol, 1613
Barton, R A , and others Composition of some Fat-free Carcasses and Bodies of New Zealand Sheep, 1724
Barua, Dr D N Top Growth of Cultivated Tea, 1424
Basavanna, G P Channa (Thontadarya, T S , and) Mode of Egg Laying in Tingidae (Hemiptera), 289
Bascom, Willard (Lill, Gordon, and) A Bore-hole to the Earth's Mantle—AMSOC's Mohole, 140
Bashkirov, Prof A N Oxidation of Organic Compounds (Oxidation of the Higher Paraffins), 327
Basic Electricity—a Course of Training developed for the United States Navy by Van Valkenburgh, Nooger and Neville, Inc , adapted to British and Commonwealth Usage by a special Electronics Training Investigation Team of the Royal Electrical and Mechanical Engineers, *review* by G R Noakes, 133
Basic Geology for Science and Engineering (Prof E C Dapples), *review* by Dr J C M Taylor, 1175
Basic Magma Deposition of Trace Elements in (R J P Williams), 44
Basic Problems in Propulsion (Combustion and Propulsion Panel of the Advisory Group for Aeronautical Research and Development Discussion on), 779
Basidiomycetes from the Soil Isolation of (J H Warcup), 506
Basilewsky, I I Silver Medal of the City of Paris awarded to, for Prof Dimitri Panov, B A 16
Basis (Genetic), of the Thalassaemia Diseases (Prof V M Ingram and A O W Stretton), 1903
Basis (A Physical), for Land Use Policy in Tropical Catchment Areas (Dr H C Pereira), 1768
Bassett, D C , and others Evidence for Distinct Sectors in Polymer Single Crystals, 810
Bassett, H G (Roberts, F F , and) Transistor Convention and Exhibition, 693
Bassir, Dr Olumbe Changes in the Level of Serum Protein during Treatment of Kwashiorkor, 2019
Bastick, M (Guerin, H , and) Coal Science (Microporosity during Gasification of Coke between 800° and 1,000° C), 414
Basu, D K , and Burma, D P Biochemical Research in India (Detection and Purification of a Stereo-specific Dihydrolipoic Acid Dehydrogenase), 1368
Basu, Dr Sadhan (Chakravorty, Animesh, and) Visible Absorption Spectra of Copper-ethylene-diamine-*bis*(acetylacetone) in the Crystalline State, 50
Bat Lipase Activity in the Brown and Yellow Adipose Tissue of the (Prof J C George and J Eapen), 59
Batchelor, F R Man-made Drugs, *review*, 1597
Batchelor, Dr G K Elected an Honorary Member of the American Academy of Arts and Sciences, 409
  Appointed first head of the Department of Applied Mathematics and Theoretical Physics in the University of Cambridge, 686 , work of, 686
Bate-Smith, Dr E C , and Whitmore, Dr T C Chemistry and Taxonomy in the Dipterocarpaceae, 795
Bateman, Dr A J Genetics and the Origin of Species, 588
Bates, Prof L F The Visualization of Magnetic Processes (Presidential Address to Section A (Mathematics and Physics) of the British Association for the Advancement of Science), B A 41
Bath, Dr Markus (prepared by) Report of the Meetings of the Section for Seismology and the Physics of the Earth's Interior of the Bureau Central International de Seismologie, 154
Bathophenanthroline Estimation of μgm Quantities of Iron in Culture Medium, using (P A Seamer), 636
Bathynella chappuisi Delachaux in Britain Rediscovery of (Ian Efford), 558
Batjes, D A J Foraminifera of the Oligocene of Belgium, 321
Bats (Hibernating) Endogenous Rhythms of Body Temperature in (Prof Michael Menaker), 1251
Battaglia, F C , and Randle, P J Monosaccharide Transport in Rat Diaphragm Muscle, 1713
Battistini, A , and others Modifications in Immunological Behaviour, Electrophoretic Mobility and Colourability of Substituted Human Serum Proteins, 1571
Bauer, Arthur A (Rough, Frank A , and) Constitutional Diagrams of Uranium and Thorium Alloys, *review* by Dr D E R Hughes, 925
Bauer, D J , and Sheffield, F W Antiviral Chemotherapeutic Activity of Isatin β-thiosemicarbazone in Mice infected with Rabbit-pox Virus, 1496
Baumgardt, Dr Ernest Visual Spatial and Temporal Summation, 1951
Bawden, F C Effect of Nitrous Acid on Tobacco Mosaic Virus—Mutation or Selection?, B A 27
  Biological Problems arising from the Control of Pests and Diseases, 1101
  The Principles and Practice of Crop Protection, *review*, 1258
Bawden, F C , and others Statement on Biological and Chemical Warfare, 1018
Baxter, Prof A D Chemistry of Propellants, 778
  Basic Problems in Propulsion (Merits of Liquid Propellant Rocket Engines), 779
Bayliss, Dr L W Flow Properties of Biological Systems (Viscous Anomalies in Blood flowing through Artificial Capillaries), 1540
Bayliss, Prof N S At the Second Australian Spectroscopy Conference (Ultra-violet Spectra—Recent Theoretical Work on Solvent Effects), 1195
Baytop Dr T, and others Sugars of the Glycoside of the Root of *Marsdenia erecta* R Br , 1319
Baz, Dr I A (read by, for Dr N Vlassov), Nuclear Forces and the Few-Nucleon Problem (Binding Energies and Elastic Scattering of Light Nuclei at Low Energies), 1114
B B C Establishment of a Science Unit, 1361
Beal, J L , and others Effect of the Potassium Salt of Gibberellic Acid on the Growth and Reproduction Rate of *Paramecium multimicronucleatum* 1405
Beale, G H Cytoplasmic Inheritance (Antigenic Types in *Paramecium*), 1012
Beam Interferometry Substrate Damage in Film Thickness Measurement by (Prof G David Scott), 354
Beaman, Teofila C and others A Partial Chemical Characterization of Maize Coleoptile Cell Walls prepared with the Aid of a Continually Renewable Filter, B A 81
Beams Theory of (T Iwinski), translated from the Polish by E P Bernet, *review* by T M Charlton, 1976
Bean (*Phaseolus vulgaris*) Hypocotyls Influence of Kinetin, β-Indoleacetic Acid and Gibberellic Acid on Nuclease Activity of (Dr W Maciejewska-Potapczyk), 557
Bean (Broad), *Vicia faba* L Glyceric Acid in (R I Morrison and Dr P C Dekock), 819
Bean (Mung) Mitochondria Glutamic Dehydrogenase of (Dr D H Bone), 990
Bean (Soy-) Nodules during the Vegetative Period Redox Potentials in (Dr Helena Ebertova), 1046
Bean Plants (Soya) Translocation of Carbon-14-labelled Amino-Acids and Amides in the Stems of young (C D Nelson and P R Gorham), 855
Beard, David B Absence of Craters on the Far Side of the Moon, 1631
Beard, J Appointed to a United States Rubber Co research studentship at University College of North Staffordshire, 322
Bearing on the Microscopy of Cellulosic Fibres A Special Case of the Super-position of Crystal Plates between Crossed Polars and its (Dr N H Hartshorne), 179
Bearings Sponge-hydrostatic and Weeping (Mechanism of Animal Joints), (Dr C W McCutchen), 1284
Bearn Dr J G An Attempt to Produce Malignant Change with Deoxyribonucleic Acid from Rat Sarcoma and Hepatoma, 824
Bearn, Dr J G , and Harris, Dr F T G Relative Rates of Exchange of Potassium-42 by the Foetal Metanephros and Foetal Liver, 1959
Beatty (Chester) Research Institute Extension to the, B A 15
  Grant of £40,000 from the Wellcome Trust, B A 15
Beaudry, J R , and Chabot, D L Chromosome Numbers in *Solidago*, 236
Beaven, Dr G H , and Gratzer, W B Direct Spectroscopic Examination of Electrophoretic Zones in Agar Gel, 359
  Foetal Haemoglobin in the Monkey, 1730
Beaven, Dr G H , and others A Haemoglobin with Unusual Alkaline-denaturation Properties in a Turkish-Cypriot Woman, 1876
Beaver, Sir Hugh Elected president of the Royal Statistical Society, 26
  Progress of Chemical Engineering in Britain (Presidential Address to the Institution of Chemical Engineers), 408
Beckel, Prof W E Sectioning Large Heavily Sclerotized Whole Insects, 1584
Beckman, H , and others Affinity of Lysozyme to Structural Elements of the Bacterial Cell as studied with Enzyme Labelled with Radioactive Iodine, 1744
Beckwith, R S Titration Curves of Soil Organic Matter, 745
Bedford, Carole, and others Spectrophotofluorometric Assay of Griseofulvin, 364
Bedford, Dr T Heating and Ventilation (Requirements for Satisfactory Heating and Ventilation), 1987
Bedford College, London Title of reader in psychology in the University of London conferred on Dr J Wynn Reeves, 322
  Appointment of Dr D E Cheesman to the University of London readership in biochemistry, 595
  Appointment of Dr P B D de la Mare to the University of London chair of chemistry, 1613, 1913
  Retirement of Prof E E Turner as head of the Department of Chemistry, 1913
Bedford Institute of Oceanography, 769
Beef Cattle (*Bos taurus* and *Bos indicus*) A Possible Explanation for Part of the Difference in Heat Tolerance Exhibited by (H P Ledger), 1405
Beer, Stafford Personnel Management and Technological Change (Organization and Mode of Working of an Operational Research Department), 1615
Beer and other Beverages Carbon Dioxide in Water, in Wine, in (F Justin Miller), *review* by Dr A H Cook, 302
Bees Electronic Prediction of Swarming in (E F Woods), 842
Bees (Bumble-), (Dr John B Free and Dr Colin G Butler), *review* by Dr M Delia Allen, 1178
Bees (Honey), *Apis mellifica* L Isolation of 24-Methylene-cholesterol from (Dr M Barbier, Prof T Reichstein, Dr O Schindler and Prof E Lederer), 732
Bees (Queen) Extraction and Purification of 'Queen Substance' from (Dr C G Butler, Dr R K Callow and Norah C Johnston), 1871
Beet (Fodder), Mangels and Swedes (National Institute of Agricultural Botany Leaflets on), 1777
Beetle, A A Origin and Dispersal of Flowering Plants (Differences in Grass Distribution in the southern part of central Wyoming due to differences in the Age and Origin of the various Species), 1200
Beetle (Colorado Potato), *Leptinotarsa decemlineata* (Say) Common Attractant for the Tobacco Hornworm, *Protoparce sexta* (Johan) and the (Dr Robert T Yamamoto and Prof G Fraenkel), 206

Beetle (Khapra) Dormancy of the—Quiescence or Diapause (H D Burges), 1741
Beetle (Scolytid) Release by Flight Exercise of a Chemotropic Response from Photopositive Domination in a (Prof Kenneth Graham), 283
Beevers, C J (Honeycombe, R W K, and) Atomic Mechanisms of Fracture (Suppression of Necking, even in Single Crystals of a Face-centred Cubic Material), 325
Behavior Dynamics of (Prof Robert S Woodworth), *review* by Prof O L Zangwill, 1523
Behavior of Enzyme Systems (Dr John M Reiner), *review* by Dr J B Chappell, 388
Behaviour Animal (Dr John Paul Scott), *review* by Dr F Fraser Darling, 302
  Evolution of, *review* by Dr W H Thorpe, 1762
Behaviour in Conventional and Extra-Terrestrial Flight (Air Commodore W K Stewart), 578
Behaviour of the *F*2 Layer of the Ionosphere Two Anomalies in the (Sheila Croom, Audrey Robbins and J O Thomas), 2003
Behaviour of Haptoglobin during Routine Fractionation (Marion Steinbach and L Pejaudier), 362
Behaviour on Hydrolysis 1-Glyceryl-2-*myo*-inosityl Phosphate—Alternative Synthesis and (Synthesis and Properties of 1-Glyceryl-2-*myo*-inosityl Phosphate), (R B Ellis and J N Hawthorne), 790
Behaviour in Rats Application of Biometrical Genetics to (Dr P L Broadhurst), 1517
Behaviour of Sea Urchins (A N Sinclair), 783
Behaviour of Zinc and Radiozinc in Tumour-bearing Rats (Dr D M Taylor), 1649
Behaviour Patterns in a Hemileucine Moth Central Control of Interactions between (Dr A D Blest), 1164
Behaviour (Crack), at a Weld Structure Discontinuity (F J Radd), 542
Behaviour (Driver) A Simulator for Research on (Prof J H Mathewson), 237
Behaviour (Emotional and Motor), in Experimental Animals Differential Analysis of the Effects of Phenothiazine-Tranquillizers on (Dr M Taeschler and Dr A Cerletti), 823
Behaviour (Immunological), Electrophoretic Mobility and Colourability of Substituted Human Serum Proteins Modifications in (M Steinbuch, Dr J M Fine and A Battistini), 1571
Behaviour (Motor) Possible Rôle of Higher Proprioceptive Centres in the Perception of Visual Space and in the Control of (Dr B Gurevitch), 1219
Behaviour (Photochemical), of Retinene (Photochemical and Stereochemical Properties of Carotenoids at Low Temperatures), (Dr Lawrence Jurkowitz), 614
Behaviour (Probing), of *Aedes aegypti* (L) in Response to Heat and Moisture (L Burgess), 1968
Behavior and Evolution (edited by Anne Roe and George Gaylord Simpson), *review* by Dr W H Thorpe, 1762
Behavior and Reactions of the Pacific Sardine *Sardinops caerulea* (Girard) under the Influence of White and Colored Lights and Darkness (Dr A S Loukashkin and Dr N Grant), 865
Behinic Acid Presence of, in Sphingomyelin from Horse Spinal Cord (Prof Yasuhiko Fujino and Takashi Negishi), 817
Beier, Max Zur Kenntnis der Pseudoscorpioniden-Fauna des Andengebietes, (Beiträge zur Neotropischen Fauna), *review* by Dr F A Turk, 1177
Being Knowing and (British Society for the Philosophy of Science Symposium on), 1193
Being Human The Importance of (Dr E L Mascall), *review* by the Very Rev W R Matthews, B A 2
Bekierkunst, Dr A, and Artman, M Effect of Cell-Free Extracts from *Mycobacterium tuberculosis* $H_{37}Rv$ on Lung Succinooxidase, 458
Belcher B J Measurement of the Effects of Piston Mass and Bursting Pressure on the Motion of a Piston in a Hypersonic Gun Tunnel, 1207
Belcher, Dr R Awarded the title of professor of analytical chemistry in the University of Birmingham, 679 , work of, 679
  River Pollution, *review*, 1177
Belevitch, Dr V Modern Network Theory in Electrical Engineering (Treatment by Matrix Algebra of the Realizability Theory for General Linear, Stable Networks with *n* Terminal-pairs), 1691
Belgian Congo Haemoglobin *P* in a Family in the (Dr Paulette Dherte, Dr H Lehmann and Dr J Vandepitte), 1133
  Mammals of the, 155
  Soil Fungi in the, 236
Belgium Foraminifera of the Oligocene of (D A J Batjes), 321
Belk, J A Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Molybdenum Crystals up to ½ in in Diameter), 691
  Impact Ductile Molybdenum, 897
Bell, Dr D A Electron Technology, *review*, 83
Bell, Dr D A, and Allanson, J T Appointed joint acting heads of the Department of Electrical Engineering in the University of Birmingham, 1688
Bell, Dr Eugene, and others Limb Development in the Absence of Ectodermal Ridge, 1736
Bell, Dr G M Elementary Statistical Physics, *review*, 1178
Bell, Jacob Tribute paid by the Pharmaceutical Society of Great Britain on the hundredth anniversary of the founder's death (Gwilyn Hughes), 23
Bell, Dr P R Appointed to the University of London readership in botany at University College, 1535
  Deoxyribonucleic Acid in Eggs of the Polypodiaceous Ferns, 1664
Bell Telephone Laboratories Non-Oxide Glasses, 594
Bellamy, D J Occurrence of *Schoenus nigricans* L on Ombrogenous Peats, 1590
Bellelli, Luciano (Guerritore, Prof Dino, and) Interaction between Nucleic Acid and a Cationic Detergent, 1638
Beller, Dr F K Flow Properties of Biological Systems (Rheological Changes in Human Mucus during the Menstrual Cycle), 1539
Beloff, Dr John, and Warwick, Kenneth Chance and Probability (Wishful Seeing in a Gambling Situation), 497
Belousov, Academician V V Elected to foreign membership of the Geological Society of London, 1360
Benacerraf, Dr Baruj, and others Effect of Bacillus Calmette-Guerin Infection on Transplanted Tumours in the Mouse, 291
Bendall, J R Flow Properties of Biological Systems (Form of the Deformation-time Curves and the Biochemical Processes underlying the Changes in Living Skeletal Muscles), 1540
Bender, M A. Biological Effects of Low Doses of Ionizing Radiations (Effects on Human Cells in Tissue Culture), 1112
Benedict, Ruth An Anthropologist at Work—Writings of (Dr Margaret Mead), *review* by Prof E E Evans-Pritchard, 301
Bengough, Dr W I, and others A Modified Rotating-Sector Method of Measuring Kinetic Chain Lifetimes, 266
Benjamin, Dr B Numbers of People, *review*, 1521
Bennacerraf, B (Gell, P G H, and) Delayed Hypersensitivity, 1030
Bennet-Clark, Prof T A Plant Growth Regulation (Effect of Gravity on the Distribution of Auxins), 599
Bennett, G H J Appointed lecturer in industrial metallurgy at the University of Birmingham, 1915
Bennett, H Special Ceramics (Chemical Determination of Nitrogen in Refractory Nitrides), 1117
Bennich, H, and others Action of Trypsin on α-Carbethoxy-L-lysyl-L-serylglycine and its O-Phosphorylated Analogue, 187
  O-Phosphorylated and Unphosphorylated Peptide-Substrates suitable for Tryptic Action, 270
Bensch, Klaus G, and others Unimpaired Mitosis in Cells with Modified Deoxyribonucleic Acid, 1429
Benson, Dr R S Appointed to a senior lectureship in mechanical engineering in the University of Liverpool, 410
Benthos of Soft Sea-bottom in Arctic North America (Dr D V Ellis), B A 79
Bentley, K W The Alkaloids (The Chemistry of Natural Products, Vol 1), *review* by Prof A J Birch, 754
Bentley, P J Effects of Elevated Plasma Sodium Concentration on Sodium and Potassium in the Erythrocyte of the Lizard *Trachysaurus rugosus* (Gray), 1403
Bentley, Prof Ronald, and Thiessen, Clara P Tropolone Biosynthesis—the Enzymatic Decarboxylation of Stipitatonic and Puberolonic Acids, 552
Bentonite Particles Detection of Thyroid Antibodies using (Dr J A M. Ager, Dr M S R Hutt and G Smith), 478
Bentzon, Michael Weis Awarded a Carlsberg–Wellcome Travelling Research Fellowship, 683
Benzene and Borazole Substituents Intermolecular Distances and Diamagnetic Anisotropy in Crystals as Measures of the Polarity of (Dame Kathleen Lonsdale), 1060
Benzene Hexachloride in Houseflies Pentachlorocyclohexene as a Possible Intermediate Metabolite of (R G Bridges), 1337
γ-Benzene Hexachloride and Dieldrin Resistance of Houseflies to (R G. Bridges and J T Cox), 1740
Benzian, B (Warren, R G, and) High Levels of Phosphorus and Die-Back in Yellow Lupins, 1588
Benzoate Change of Absorption Spectrum of Flavin Adenine Dinucleotide by its Binding with both D-Amino Acid Oxidase Apo-Protein and (Dr Kunio Yagi, Takayuki Ozawa and Minoru Harada), 1938
Berberine Alkaloids via 6,7-Dimethoxy*iso*quinoline-1-aldoxime (Dr C K Bradsher and Dr N L Datta), 1943
Berengario da Carpi, Jacopo A Short Introduction to Anatomy (Isagogae Breves), translated with an Introduction and Historical Notes by L R Lind, and with Anatomical Notes by Paul G Roofe, *review* by Dr A R Hall, 1761
Berg, Daniel (Dakin, T W, and) Luminous Spots on Electrodes in Insulating Oil Gaps, 120
Berge, Grim Polar Front Survey (Biology—Productivity of the Norwegian Sea), 1183
Berger, S, and others Effect of 'Amino-Acid Imbalance' on Growth and Vitamin A Storage in the White Rat, 1404
Bergeron, Dr J A, and Fuller, Dr R C Influence of Carotenoids on the Infra-Red Spectrum of Bacteriochlorophyll in *Chromatium*, 1340
Bergmann, Ludwig A New Technique for Isolating and Cloning Cells of Higher Plants, 648
Bergstrom, E, and others Sodium Regulation in the Blood of Parr and Smolt Stages of the Atlantic Salmon, 283
Bergstrom, Dr Jonas Determination of Chlorine in Muscle Tissues by Neutron Activation Analysis, 1504
Berkner, L V, (edited by, in association with John Hanessian, Jr, and Leonard Cormier) Manual on Rockets and Satellites, *review*, 213
Berlin, Sir Isaiah Elected an Honorary Member of the American Academy of Arts and Sciences, 409
Bernal, Prof J D Fluctuation Phenomena and Stochastic Processes, 509
  Energy Transfer with special reference to Biological Systems, 689
Bernays, Prof Paul Axiomatic Set Theory, *review* by Dr L S Goddard, 1178
Bernhard, Dr W Cytoplasmic Inheritance (Fine Structure of Cytoplasm), 1012
Bernlohr, Robert W, and Novelli, G D Antibiotic Production as a Function of Spore Formation in *Bacillus licheniformis*, 1256
Bernstein, I B, and Rabinowitz, I N Ionization Phenomena in Gases (Velocity Distribution of Plasma Electrons in an External Magnetic Field), 1357
Berridge, Dr N J Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 859 , work of, 859
Berry, Prof H The Strategy of Chemotherapy, *review*, 133
Berson, Dr Solomon A (Yalow, Dr Rosalyn S, and) Assay of Plasma Insulin in Human Subjects by Immunological Methods, 1648
Bertram, Dr G C L Biological Problems arising from the Control of Pests and Diseases ('Ethical' of Deliberate Selection in Mankind has supplanted Natural Selection), 1102
Bertinchamps, Dr Albert J, and others Thirst for Bile in Rats with Bile Fistulae, 1405
Bessis, Dr M Awarded a grant by the Lady Tata Memorial Trust, for research on Leukaemia and allied diseases, 507
β-Amino-*iso*butyric Acid in Mongolism Urinary Excretion of (Dr Thomas L Perry, Dr Kenneth N F Shaw and Dr Dorothy Walker, 1970
β-Amino-*iso*butyric Acid Excretors High Prevalence of High-Level, in Micronesians (Dr B S Blumberg and Dr S M Gartler), 1990
β-Globulin Alleles in some Zebu Cattle (G C Ashton), 1135
β-Glycosides (α- and) A Method for Distinguishing between, by the use of Plant Haemagglutinins (Lectins), (Dr O Makela), 111

β-Glucuronidase Localization of, in Normal and Cancer Cells (J Conchie and Dr G A Levvy), 1709
β-Glucuronidase Activity (Urinary), in Patients with Bone Fractures (F J W Lewis and Dr Constance H J Plaice), 1249
β-Indoleacetic Acid and Gibberellic Acid Influence of Kinetin, on Nuclease Activity of Bean (*Phaseolus vulgaris*) Hypocotyls (Dr W Maciejewska-Potapczyk), 557
DL-β-Phenylserine Influence of, on the Synthesis of Proteins in *Escherichia coli* (J Janeček, J Chaloupka, K Vereš and M Havranek), 1895
Betin, Dr V V, and Preobragenski, Prof J V Polar Front Survey (Hydrography—Ice Research in the Baltic), 1183
Betke, Prof K, and others Estimation of Small Percentages of Foetal Haemoglobin, 1877
Bett, Dr W R *Obituary* of Dr W W Francis, 316
  Sir Charles Hastings, *review*, 923
Bettex-Galland, M, and Luscher, Dr E F Extraction of an Actomyosin-like Protein from Human Thrombocytes, 276
Bevelander, Gerrit, and others Inhibition of Skeletal Formation in the Chick Embryo following Administration of Tetracycline, 728
Beverages Carbon Dioxide in Water, in Wine, in Beer and in other (F Justin Miller), *review* by Dr A H Cook, 302
Beveridge, Lord A Defence of Free Learning, *review* by R Brightman, 576
Beveridge, J M R (Coleman, I, and) Effect of Dietary Fat and Extent of Blood Sampling on the Level of Plasma Cholesterol in the Rat, 1039
Beveridge, Prof W I B Elected president of the newly formed World Veterinary Association, 853, work of, 853
Beverley, Dr J K A, and Watson, W A Ovine Abortion due to Toxoplasmosis, 2041
Bevington, J C Macromolecules (Applications to Polymer Studies of Radioactive Labelling), 1690
Bezzi, G, and Gessa, G L Neuromuscular Blocking Action of some Antibiotics, 905
Bhagavantam, Dr S Biochemical Research in India, 1367
Bhargava, Dr P M Protein Synthesis, 1368
Bhat, M G Biochemical Research in India (Nutrition and Metabolism of *Pseudomonas convexa* var *hippuricum*) 1367
Bhati, A Appointed to a research fellowship in chemistry in the University of Glasgow, 1915
Bhatia, I S, and co-workers Biochemical Research in India (Transglycosidase present in Tea Leaves), 1368
Bhatia, Major-General S L Biochemical Research in India (Progress of Physiology and Biochemistry in India), 1367
Bhattacharya, Dr Gangagobinda Rôle of Magnesium in the Insulin-Sensitivity of the Rat Diaphragm *in vitro*, 1401
Bhattacharya, Kshirod R The Coloured Product of the Sakaguchi Reaction, 53
Bhattacharya, Roma, and others A New Nitrogen-fixing Bacterium, 1743
Bhattacharya, Dr S K Inhibition of Liver Hexokinase by Dehydroascorbic Acid and Alloxan, 1638
Bhavsar, M D, and others Inhibition of Tumour Growth with 2 5-Dicarbethoxy-3 4-Dihydroxy-Thiophene, 201
BHC in Houseflies Pentachloro*cyclo*hexene as a Possible Intermediate Metabolite of (R G Bridges), 1337
γ-BHC and Dieldrin Resistance of Houseflies to (R G Bridges and J T Cox), 1740
Bibby, Dr Cyril T H Huxley—Scientist, Humanist and Educator, *review* by Lord James of Rusholme, B A 2
Bibliography on Medical Electronics (prepared by the Medical Electronics Center of the Rockefeller Institute), 1026
Bibliography of Scientific Publications of South and South-East Asia (Unesco Science Co-operation Office), Vol 5, No 6, 772
Bickerstaff, E R, and others Ultrastructure of the Myoneural Junction in Myasthenia Gravis, 1500
Bickerton, R Thermonuclear Processes, 240
Bidder, Anna M Kingdom of the Octopus, *review*, 218
Bidgood, D E T (Harland, W B, and) Palaeomagnetism in some Norwegian Sparagmites and the Late Pre-Cambrian Ice Age, 1860
Bier, Milan (edited by) Electrophoresis—Theory, Methods and Applications, *review* by Dr R Consden, 84
Bieri, Dr John G An Effect of Selenium and Cystine on Lipide Peroxidation in Tissues Deficient in Vitamin E, 1148
Bieri, Prof Robert Dimorphism and Size Distribution in *Velella* and *Physalia*, 1333
Biggs, P M, and Payne, L N Cytological Identification of Proliferating Donor Cells in Chick Embryos injected with Adult Chicken Blood, 1594
Bijl, Dr D Appointed reader in natural philosophy in St Salvator's College, St Andrews, 684
Bilbey, Prof D L J, and Salem, Dr H Influence of Sulphur Dioxide Inhalation on the Phagocytic Activity of the Macrophage System, 722
  Assessment of the Phagocytic Activity of the Macrophage System, 992
Bile Thirst for, in Rats with Bile Fistulae (Dr Albert J Bertinchamps, James J Greenough and George C Cotzias), 1405
Bile (Seminal Plasma, Serum and) Visualization of Acid and Alkaline Phosphatase after Starch-Gel Electrophoresis of (Dr Bengt Estborn), 1636
Bile Fistulae Thirst for Bile in Rats with (Dr Albert J Bertinchamps, James J Greenough and George C Cotzias) 1405
Billen, Daniel Influence of Unbalanced Growth on subsequent X-Ray Induced Inhibition of Deoxyribonucleic Acid Synthesis in *Escherichia coli* 15T, 174
Billingham, Flight-Lieut J Heating and Ventilation (Physiological Aspects of Cabin Air-conditioning in Military Aircraft), 1987
Billingham, Dr R E, and Koprowski, Dr H The Wistar Institute of Anatomy and Biology, Philadelphia, B A 6
Billingham, Dr R E, and Silvers, Dr Willys K The Structure of Science (Tissue Transplantation Angigen), B A 9
Billings, Dr A R Appointed professor of electrical engineering in the University of Western Australia, 93, work of, 93
Binaghi, R, and others Promoting Effect of Urea on the *in vitro* Passive Sensitization of Isolated Plain Muscles with Precipitating Antibody, 1805
Binary Alloys Constitution of (Dr Max Hansen) second edition, prepared with the co-operation of Dr Kurt Anderko, *review* by Dr F C Thompson, 1765
Binary Gas Mixtures Sensitivity of Catharometers in Gas Chromatography and the Thermal Conductivity of (A B Littlewood), 1631
Binary Solid Solutions (Dilute), of Bismuth in Tellurium and Tellurium in Bismuth Some Semiconductive Properties of (Dr Tomasz R Piwkowski), 355
Binary Systems Estimation of the Interchange Energy for, from Mutual Solubility Data (Kiyoharu Ishida), 814
Bindal V N (Parthasarathy, S, and) Ultrasonic Absorption in Acetic Acid at 450 kc /s by the Calorimetric Method, 631
Binding with both D-Amino Acid Oxidase Apo-Protein and Benzoate Change of Absorption Spectrum of Flavin Adenine Dinucleotide by its (Dr Kunio Yagi, Takayuki Ozawa and Minoru Harada), 1938
Binding of Haem to Protein in Haemoglobin and Myoglobin (Dr J E Falk, Dr J N Phillips and Dr D D Perrin), 1651, (Dr J E O'Hagan), 1652
Binding of the Sulphydryl Group in D-Amino-Acid Oxidase Apo-Protein with Flavin Adenine Dinucleotide (Dr Kunio Yagi and Takayuki Ozawa), 1227
Bingold, A C, and France, W G Biomechanics (Film on Late Results of Four Massive Internal Prosthesis), 513
Binns, Dr W O Conservation in the Scottish Highlands, 1529
Biochemical Assay Systems involving Nitrite Estimation by Diazotization Measurement of Inhibition by Azide in (Dr E J Hewitt and D G Hallas), 1485
Biochemical Components (Parental), in a *Baptisia* Hybrid Population Applications of Paper Chromatography to Systematics—Recombination of (Dr R E Alston and Dr B L Turner), 285
Biochemical Engineering—Unit Processes in Fermentation (edited by Dr R Steel), *review* by Dr N Blakebrough, 1598
Biochemical Journal Resignation of Dr A G Ogston from the chairmanship of the Editorial Board, 508
  Appointment of Dr W V Thorpe as chairman of the Editorial Board, 508
Biochemical Mechanism of Lesion Formation in Virus-infected Plant Tissues (Dr F Solymosy, Dr G L Farkas and Dr Z Kiraly), 706
Biochemical Method Clinical (Dr A L Tarnoky), *review* by Dr D S H W Nicol, 576
Biochemical Research in India—Golden Jubilee Symposium (Prof P S Sarma), 1367
Biochemical Society Symposium on the Biosynthesis and Secretion of Adrenocortical Steroids, 415
  Symposium on Steric Aspects of the Chemistry and Biochemistry of Natural Products, 947
  Appointment of Dr P N Campbell as secretary to the Committee, 1192
  Appointment of Dr W J Whelan as meetings secretary, 1192
Biochemist's Guide to the Nervous System, *review* by Dr G B Ansell, 1261
Biochemistry at Birmingham, 679
Biochemistry and the Central Nervous System (Prof Henry McIlwain), second edition, *review* by Dr G B Ansell, 1261
Biochemistry of Micro-organisms Biology and (Indian Institute of Science Symposium on), 1367
Biochemistry of Natural Products Steric Aspects of the Chemistry and (Biochemical Society Symposium on), 947
Biochemistry, International Union of (organized by the Science Council of Japan under the auspices of the) Proceedings of the International Symposium on Enzyme Chemistry (Tokyo and Kyoto, 1957), *review* by Dr J B Chappell, 388
Biochemists (Clinical), Association of Election of Officers, 857
Biogenesis (Protein) Specificity in (Centre Interuniversitaire de Recherches enzymologiques Colloquium on), 1198
Biogeochemical Enrichment of Fission Products (Prof Pontus Ljunggren), 912
Biological Action of Deoxyribonuclease I on the Growth of *Euglena gracilis* (Dr Rudolf K Zahn), 1324
Biological Action of Potassium-40 in Naturally Occurring Potash Salts (Prof E Welte and Kl Mechsner), 1958
Biological Ashes (Marine) Some Activation Analyses of Six Trace Elements in (R Fukai and Prof W W Meinke), 815
Biological Assay Systems Interference by Azide with Diazotization Procedures used in (J R Villanueva), 549
Biological Association, Freshwater Twenty-seventh Annual Report (1958-59), 1845
Biological Characteristics (Chromatographic and), of Fish and Frog Neurohypophysial Extracts (Active Principles of the Neurohypophysis of Cold-blooded Vertebrates), (B T Pickering and Prof H Heller), 1463
Biological Clock in *Neurospora* (Growth Patterns in *Neurospora*) (C S Pittendrigh, Dr V G Bruce, N S Rosenweig and M L Rubin), 169
Biological Effects Incorporation of 5-Bromouracil into Transforming Principle of *Bacillus subtilis*, and its (Dr Erela Ephrati-Elizur and Prof Stephen Zamenhof), 472
Biological Effects of Low Doses of Ionizing Radiations (Unesco, the International Atomic Energy Agency and the Comitato Nazionale per le Ricerche Nucleari Symposium on), 1111
Biological Fibres (X-Ray Analysis Group of the Institute of Physics Conference on), B A 25
Biological Half-Life of Radioiron in Man (R Oliver and Dr L G Lajtha), 1882
Biological Laboratory Data (Dr L J Hale), *review* by Prof R C McLean 577
Biological Material Spectroscopic Identification of Alpha-Emitting Nuclides in (Prof W V Mayneord and C R Hill) 667
Biological Media Ionized Calcium in (Prof J Ettori and Sybil N Scoggan), 1315
Biological Origin and Configuration of 10-Hydroxy-Δ^2-decenoic Acid (Dr S A Barker, Dr A B Foster D C Lamb and Dr L M Jackman), 634
Biological Problems arising from the Control of Pests and Diseases (Institute of Biology Symposium on), 1100
Biological Properties of Coal and Coal Extracts (Dr A A Mills), 1885
Biological Properties of Phenols of Plant Origin, *review* by Dr F A Robinson, 486
Biological Research Electronic Apparatus for (P E K Donaldson), *review* by W J Perkins, B A 4
  Future Marine, *review* by Dr J A Allen, 215

Biological Sciences (edited by J G Bugher, J Coursaget and J F Loutit), Vol 2, *review* by Prof G Pontecorvo, 1902
Biological Systems Energy Transfer with special reference to (Faraday Society Discussion on), 688
  Flow Properties of Blood and other (British Society of Rheology and the Colloid and Biophysics sub-Committee of the Faraday Society Discussion on), 322, 1539
Biological (Non-Medical) Problems of Nuclear Physics, Development Commission on (Agricultural Research Council, the Medical Research Council and the) Appointment of Sir James Denby Roberts as chairman of the Joint Committee of the, 237
Biological and Chemical Warfare Pugwash International Conference of Scientists—Statement on, 1018
Biological and Medical Physics Advances in, Vol 6 (edited by Cornelius A Tobias and John H Lawrence), *review* by Dr N M Blackett, 1766
Biological and Physical Properties Turnip Yellow Mosaic Virus Nucleoprotein Particles with differing (R E F Matthews), 530
Biologically Active Fractions of Deoxyribonucleic Acid Immunization with, and Subsequent Specific Infection of Mice (Dr M Kohoutova), 1965
Biologie des Grands Mammiferes Ecologie et (Primates, Carnivores, Ongulés), (Jacques Verschuren), (Exploration du Parc National de la Garamba, Mission H de Saeger, Fasc 9), 155
Biology Comparative Studies of Ultra-structure in (Dr J Lowy), 1445
  Developmental, *review* by Dr D R Newth, 839
  Electronics in, *review* by W J Perkins, B A 4
Biology Developmental, No 1, 236
Biology Institute of Symposium on Biological Problems arising from the Control of Pests and Diseases, 1100
Biology, Institute of (Scottish Branch) Symposium on Conservation in the Scottish Highlands, 1529
Biology The Wistar Institute of Anatomy and, Philadelphia (Dr R E Billingham and Dr H Koprowski), B A 6
Biology of *Amoeba* (Monica Taylor), 1371
Biology (Developmental) Conference Series, 1956—Cytodifferentiation (edited by Dorothea Rudnick), Environmental Influences on Prenatal Development (edited by Beatrice Mintz), Regeneration in Vertebrates (edited by Charles S Thornton), Embryonic Nutrition (edited by Dorothea Rudnick), Immunology and Development (edited by M V Edds, Jr), Dynamics of Proliferating Tissues (edited by Dorothy Price), Wound Healing and Tissue Repair (edited by W Bradford Patterson), (United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Biology (Marine) Perspectives in—a Symposium held at Scripps Institution of Oceanography, 1956 (edited by A A Buzzati-Traverso), *review* by Dr J A Allen, 215
Biology and Biochemistry of Micro-organisms (Indian Institute of Science Symposium on), 1367
Biology and Physics (British Society for the Philosophy of Science Symposium on), 1193
Biology (Medical), and Etruscan Origins Ciba Foundation Symposium on (edited by G E W Wolstenholme and Cecilia M O'Connor), *review* by Madelaine Smith, 1348
Biomechanics (Institution of Mechanical Engineers Symposium on), 512
Biometrical Genetics Application of, to Behaviour in Rats (Dr P L Broadhurst), 1517
Biondi, M A Ionization Phenomena in Gases (Technique for the Measurement of Attachment Coefficients for very Low-energy (nearly Thermal) Electrons in Oxygen and Nitrogen), 1354
Bionomics of the Brush-tailed Opossum *Trichosurus vulpecula* in New Zealand (R I Kean), 1388
Biophysical Chemistry Progress in Biophysics and (edited by Prof J A V Butler and Prof B Katz), Vol 9, *review* by P A Merton, 1092
Biophysics and Biophysical Chemistry Progress in (edited by Prof J A V Butler and Prof B Katz), Vol 9, *review* by P A Merton, 1092
Biosynthesis Tropolone—the Enzymatic Decarboxylation of Stipitatonic and Puberulonic Acids (Prof Ronald Bentley and Clara P Thiessen), 552
Biosynthesis of some Amino-Acids from Sucrose by Germinating Uredospores of Wheat Stem Rust, Race 15B (B Kasting, A J McGinnis and W C Broadfoot), 1943
Biosynthesis of Carotenes in Carrot Extracts (Dr V V Modi and D K Patwa), 983
Biosynthesis of Chondroitin Sulphates (J B Adams), 274
Biosynthesis of Corynomycolic Acid from Two Molecules of Palmitic Acid (Dr Mireille Gastambide-Odier and Prof E Lederer), 1563
Biosynthesis and Secretion of Adrenocortical Steroids (Biochemical Society Symposium on), 415
Biosynthesis (Ascorbic Acid) Stimulatory Effect of Foreign Compounds on, and on Drug-Metabolizing Enzymes (Dr A H Conney and Dr J J Burns), 363
Biosynthesis (Haem and Porphyrin) Effect of Oxygen Tension on (J E Falk, R J Porra and Ann Brown, and F Moss and Helen E Larminie), 1217
Biosynthesis (Protein), and Oxidative Phosphorylation in Isolated Rat Liver Mitochondria (P J Reis, J L Coote and T S Work), 165
Biosynthesis (Ribonucleic Acid) Kinetics of Virus Protein and (Replication of Tobacco Mosaic Virus), (Prof Barry Commoner, Dr James A Lippincott and Dr Janey Symington), 1992
Birch, Prof A J The Terpenes, *review*, 302
  The Chemistry of Natural Products, *review*, 754
Birch Seedlings Early Induction of Flowering in (Dr K A Longman and Prof P F Wareing), 2037
Bird, Dr G W G Anti-A Haemagglutinins from a Non-Leguminous Plant, *Hyptis suaveolens* Poit, 109
Bird (Equatorial), *Quelea quelea* Effect of Photoperiod on the Gonadal Cycle in an (Dr Albert Wolfson and David P Winchester), 1658
Bird (Xerophilous Equatorial), *Quelea quelea* Duration of the Regeneration Period of the Internal Reproductive Rhythm in a (H J de S Disney, B Lofts and Dr A J Marshall), 1659
Bird Paintings (Some Eighteenth Century), in the Library of Sir Joseph Banks (1743-1820), (Averil Lysaght), 941
Birds The (Oskar and Katharina Heinroth), English edition prepared by Michael Cullen, *review*, 1439
  Radar Echoing Area Polar Diagrams of (J Edwards and E W Houghton), 1059
  Resident British (Educational Productions, Ltd, Filmstrip CX 6208), 1777
Birds of the Palearctic Fauna—Order Passeriformes (Dr Charles Vaurie), *review* by Sir Landsborough Thomson, 666
Birds of Prey, *review* by Sir Landsborough Thomson, 1435
Birds of Sydney (County of Cumberland), New South Wales (K A Hindwood and A R McGill), *review* by Dr A J Marshall, 841
Birds (Captive Marine), possessing a Functional Lateral Nasal Gland (Salt Gland), (Prof Larry Z McFarland), 2030
Birds (Gallinaceous) Immunological Distances among some (Danilo Mainardi), 913
Birefringence of Montmorillonite Complexes (R Greene-Kelly), 181
Birkbeck College, London Title of reader in zoology in the University of London conferred on T E Hughes, 322
Birkett, L, and Wood, R J Shell and Siphon Regeneration in *Mactra stultorum* Linne (Lamellibranchiata), 1075
Birks, Dr J B, and Kuchela, K N Energy Transfer with special reference to Biological Systems (Polystyrene Solutions as a Function of Wavelength), 689
Birks, Dr J B, and Schulman, Dr J H (edited by) Progress in Dielectrics, Vol 1, *review* by Dr V Daniels, 1175
Birks, Dr R, and others Dissociation of the 'Surface Membrane Complex' in Atrophic Muscle Fibres, 1507
Birlec, Ltd Name to be changed to A E I-Birlec, Ltd, 1535
Birmingham, Dr Marion K Use of Porter-Silber and Schiff Reagents as Spot Tests for Steroids applied on Paper and their Application to the Study of Rat Adrenal Lipids, B A 67
Birmingham The Graduate School in Mathematical Physics at (Prof R E Peierls), 96
Birmingham Museum of Science and Industry Account of the Workshops reconstructed in the (Keith Dunham), 1534
Birmingham Natural History and Philosophical Society Records and Activities (K L Kenrick), 1024
Birss, I R Bubble Counting on Low-Energy Particle Tracks, 1474
Birstein, Y A Determination of the Temperatures of Ancient Seas by the Measurement of the Oxygen Isotopes Ratio in Fossil Calcareous Organisms, 1025
Birth Rates in the United States since 1870 Trends in (Dr Bernard Okun), *review*, 134
*Bis*dithiocarbamates (Ethylene) Insecticidal Action of (R D McMullen), 1338
Bishop, F Tallowy Discoloration in Cheddar Cheese—Fat Oxidation and Trace Metals in Cheese, 1295
Bishop, Prof R E D Mechanical Impedance Methods in Vibration, *review*, 1764
Bishop (Bernice P) Museum, Hawaii Grant of 171,600 dollars from the United States National Science Foundation, 683
Bisht, V K, and others Ionization Phenomena in Gases (Post-arc Behaviour of two Practical Circuit Breakers), 1355
Bismuth in Tellurium and Tellurium in Bismuth Some Semiconductive Properties of Dilute Binary Solid Solutions of (Dr Tomasz R Piwkowski), 355
Bismuth Telluride and related Compounds Stoichiometry of (G Offergeld and J van Cakenberghe), 185
Bisset, Dr K A Characters associated with Parasitism in Gram-Positive Bacteria, B A 29
Bituminous Coals Structure of—Evidence from Distribution of Hydrogen (Dr P H Given), 980
Biuret Reaction Crystallographic Studies of the (Dr H C Freeman, J E W L Smith and J C Taylor), 707
Bjelland, B and others The *D* Region of the Ionosphere, 973
Bjellerup, L Thermodynamics (Experimental Thermochemistry), 1707
Bjuro, Dr T, and Westling, Dr H Sodium Chloride Intake and Urinary Histamine in Adrenalectomized Rats, 1241
Black, Dr M, and Naylor, J M Prevention of the Onset of Seed Dormancy by Gibberellic Acid, 468, *erratum*, 857
Black Marlin in British East African Waters (F Williams), B A 78
Blackett, Dr N M An Effect of Dose Fractionation on the Incidence of Bone Tumours using Radioactive Phosphorus 565
  Nuclear Energy and Medicine, *review*, 1766
Blackie and Son, Ltd Celebration of the 150th year of publishing, 1451
  Appointment of Christopher T Rivington as London scientific editor, 1451
Blackith, R E, and others Maternal Control of Ovariole Number in the Progeny of the Migratory Locust, 103
Blackman, Dr M Title of professor of physics in the University of London (at the Imperial College of Science and Technology) conferred on, 1273
Blackwell, Dr D E, and Dewhirst, Dr D W Kellogg and Ney's Model of the Solar Corona, 1120
Blackwood, J D, and McTaggart, F K A New Approach to Carbon Gasification, 447
Bladder (Gas), of *Coregonus lavaterus* Rete Mirabile in the (Goran Fahlen), 1001
Blain, Dr John A, and Styles, Edward C C A Lipoperoxidase Factor in Soya Extracts, 1141
Blair, Dr G W Scott Flow Properties of Biological Systems, 1539
Blair, Dr G W Scott (Reiner, Prof M, and) The Flow of Blood through Narrow Tubes, 354
Blakebrough, Dr N Microbes on the Move, *review*, 1598
Blakely, R M, and others Effect of Thioctic Acid on Gain in Body-Weight by Turkey Poults, 1323
Blakey, Billy R, and Gifford, Prof George E Discarded Blood Bank Blood as a Source of Protein for Cultivation of HeLa Cells, 1158
Blanc, Daniel Détecteurs de Particules (Compteurs et Scintillateurs), Mécanisme et Réalisation, *review* by Dr E B Paul, 1977
Blank, C E Appointed lecturer in medical genetics at the University of Sheffield, 684
Blankenbecler, -, and others Nuclear Forces and the Few-Nucleon Problem (Scattering of Nucleons by Light Nuclei at High Energy), 1113
Blasse, G, and others Action of Anhydrous Formic Acid on Peptides and Proteins, 2015

Blastocladiella and *Allomyces* (Water Fungi) *Gamma* Particles, Nadi-Positive Mitochondria, and Development in the (Prof Edward C Cantino and Gilbert Turian), 1889
Blastoderm (De-embryonated Chick) 8-Azaguanine Inhibition of Haemoglobin Synthesis in (B R A O'Brien), 376
Blastomeres (Isolated), of Mouse Eggs Experiments on the Development of (Dr Andrzej K Tarkowski), 1286
Blatella germanica A Simplified Method for the Culture of under Aseptic Conditions (R B Clayton), 1166
Blatt, Prof J M Nuclear Forces and the Few-Nucleon Problem (Binding Energies and Elastic Scattering of Light Nuclei at Low Energies—Ground-State Energy of the Triton), 1114
Blaxter, J H S Fishery Research, 865
Blears, J , and others The Tandem Generators of the United Kingdom Atomic Energy Authority, 303
Blest, Dr A D Central Control of Interactions between Behaviour Patterns in a Hemileucine Moth, 1164
Blin-Stoyle, Dr R J Turning Points in Physics (The End of Mechanistic Philosophy and the Rise of Field Physics), *review* by G R Noakes, 1090
Block, B P , and Cox, Dr G S Effect of Diet on the Blood Sugar and Liver Glycogen Level of Normal and Adrenalectomized Mice, 721
Block, Richard J , and others A Manual of Paper Chromatography and Paper Electrophoresis, second edition, *review* by Dr R Consden, 1436
Block (An Exteroceptive), to Pregnancy in the Mouse (Hilda M Bruce), 105
Blocking Action (Neuromuscular), of some Antibiotics (G Bezzi and G L Gessa), 905
Blocking Agent (Copper-Catalyst) Inhibition of Rous I Sarcoma Metastases by a (Dr B M Jones), 1963
Blocking Agents (Neuromuscular) Effect of some, on Mitochondrial Enzyme Systems (Dr J H Koch and Dr C H Gallagher), 1039
Blocking Drugs (Ganglion) Action of, on Choline Acetylase (Dr J E Gardiner), B A 71
Blom, L , and Caris, J Quantitative Paper Chromatography based on the Sub-Micro Titration of Derivatives containing Nitro Groups, 1313
Blood Hormone Effects on Early Distribution and Disappearance from the, of Promethium-147 in Rats (Dr Bergene Kawin), 1816
  Post-Exposure Analysis of Organic Compounds in the by a Rapid Infra-red Technique (Dr R D Stewart, D S Erley, T R Torkelson and C L Hake), 192
Blood treated with Dextran Release of Histamine from Rat Mast Cells by (Dr G T Archer), 1151
Blood through Narrow Tubes The Flow of (Prof M Reiner and Dr G W Scott Blair) 354
Blood of Parr and Smolt Stages of the Atlantic Salmon Sodium Regulation in the (Prof H J Koch, J C Evans and E Bergstrom) 283
Blood (Adult Chicken) Cytological Identification of Proliferating Donor Cells in Chick Embryos injected with (P M Biggs and L N Payne), 1594
Blood (Discarded Blood Bank), as a Source of Protein for Cultivation of HeLa Cells (Billy R Blakey and Prof George E Gifford), 1158
Blood (Duck) incubated *in vitro* Pathway of Carbon-^{14} Incorporation from $NaH^{14}CO_3$ to Haem in (A Breccia, A L Fantola E Lazzarini and A Giustina), 1879
Blood (Injected Mouse) Abrogation by, of Protective Effect of Foreign Bone Marrow in Lethally X-Irradiated Mice (L J Cole and R M Garver), 1815
Blood and other Biological Systems Flow Properties of (British Society of Rheology and the Colloid and Biophysics sub-Committee of the Faraday Society Discussion on), 322
Blood, Cerebrospinal Fluid and Urine α-Ketoglutaric Acid and Pyruvic Acid in (Dr E Zelnicek), 727
Blood Acetylcholinesterase in *Phalaris* Staggers (Dr D J Walker), 1411
Blood Anticoagulant (Bridge) Neutralization of (Dr F Nour-Eldin), 1419
Blood Bank Blood (Discarded), as a Source of Protein for Cultivation of HeLa Cells (Billy R Blakey and Prof George E Gifford), 1158
Blood Cell (Red) Receptors Influence of Streptomycin Solutions on the Interaction between the Agglutinating Sera and the Corresponding (Dr M Kout and Dr Z Kubickova), 639
Blood Cells of *Drosophila melanogaster* *In vitro* Cultivation of, in a Synthetic Medium (Dr Masakatsu Horikawa and Dr Yukiaki Kuroda), 2017
Blood Cells (Circulating) Synthesis of Haem by (Peggy Clark and Dr R J Walsh), 1730
Blood Cells (Red) Coating of, with Antigenic Substances (Dr K Deutsch), 278
Blood Cells (White), of Rats (*WR* Strain) A Sex Difference in (Dr Hans Meier), 1082
Blood Coagulating System and the Physiological Anticoagulating System Interrelations between the (Prof P A Kudrjashov), 454
Blood Constituents A Low Concentration of certain observed in Offspring of Alloxan-Diabetic Rabbits (Dr Otakar Sirek and Dr Anna Sirek) 456
Blood Corpuscles (Red) Effect of Polyphloretin Phosphate on the Suspension Stability of (Dr Bengt Fries), 62
Blood Cortisol in the Sheep—Normal Concentration and Changes in Ketosis of Pregnancy (H R Lindner), 1645
Blood Donors (406 French) Frequencies of the Haptoglobin Groups in (Dr J Moullec and Dr J M Fine), 196
Blood Elements (Injured Cellular) in Extracorporeal Circuits Release of Adenosine Triphosphate and Serotonin from (Dr H S S Sarajas, Dr R Kristoffersson and Dr M H Frick), 1127
Blood-feeding Habits of Adult Noctuidae (Lepidoptera) in Cambodia (W Buttiker), 1167
Blood Flow (Renal) Mechanism of Autoregulation of (Dr Allen M Scher), 1322
Blood Group Antigen Js^a(New) among South American Indians Frequency of the (Dr Miguel Layrisse and Dr Zulay de Layrisse), 640
Blood Group Antigen Sw_a A 'New Human (T E Cleghorn), 1324
Blood Group Methods and Techniques, *review* by Dr R A Zeitlin, 130
Blood Grouping Practical (Dr F Stratton and Dr P H Renton), *review* by Dr R A Zeitlin, 130
Blood Grouping of the Remains of Swedenborg (Madeleine Smith), 867
Blood Groups (Abo), and Fertility in a Normal American Population An Association between (Dr T Edward Reed and Dr J H Ahronheim), 611
Blood Keto-Acids in Kwashiorkor (Prof J C Edozien), 1150
Blood Sampling Effect of Dietary Fat and Extent of, on the Level of Plasma Cholesterol in the Rat (I Coleman and J M R Beveridge), 1039
Blood Serum Determination of Magnesium in, by Atomic Absorption Spectroscopy (Dr J B Willis), 186
Blood Sugar and Liver Glycogen Level of Normal and Adrenalectomized Mice Effect of Diet on the (B P Block and Dr G S Cox), 721
Blood Supply (Tumour) A Rapid Method for studying, using Systemic Dyes (Dr R J Goldacre and Dr B Sylvén), 63
Blood Velocity Patterns Intravascular and Intracardiac, recorded by means of *NTC* Resistors (Dr W G Zijlstra, J R Brunsting and L B v d Slikke), 991
Blood Vessels (Small), in Human Multiform Glioblastoma Electron Microscopical Structure of the Wall of (Dr S H M Nystrom), 65
Bloodworth, G G Appointed lecturer in elctronics at the University of Southampton, 1915
Bloor, J E , and Gartside S Effect of Hybridization Changes on the Bond Energies of Carbon–Carbon Single Bonds, 1313
Blue Material (Rice's) Some Experiments on (J W Clarke and G McTurk), 2014
Blue Tick Pyrethrum Resistance conferred by Resistance to DDT in the (G B Whitehead), 378
Blue Tick, *Boophilus decoloratus* Contents of Cystine-Cysteine, Glutathione and Total Free Sulphydryl in Arsenic-resistant and Sensitive Strains of the (Dr J S Harington), 1739
Blum, William P , and others Isomers of Vitamin A in Fish Liver Oils, 1377
Blumberg, Dr B S , and Gartler Dr S M High Prevalence of High-Level β-Aminoisobutyric Acid Excretors in Micronesians, 1990
Blundell, Dr D J Appointed lecturer in geology at the University of Birmingham, 1026, 1362
Blundell, Dr D J , and Stephenson, P J Palaeomagnetism of some Dolerite Intrusions from the Theron Mountains and Whichaway Nunataks, Antarctica, 1860
Blundell, John (Horn, Gabriel, and) Evoked Potentials in Visual Cortex of the Unanaesthetized Cat, 173
Blunt-Nosed Bodies in a High-Temperature Gas Jet (F R Sedlund and Prof C C Chang), 812
Bocher, T W Origin and Dispersal of Flowering Plants (Most Arctic or Montane Species Groups are probably of Tertiary Origin), 1200
Bockasten, K , and others Ionization Phenomena in Gases (Apparatus for the Electrode-less Generation and Acceleration of Plasma Rings), 1357
Bodanszky, Dr Miklos, and du Vigneaud, Prof Vincent A New Crystalline Salt of Oxytocin, 981, *erratum*, 1777
Boden, Dr Brian P , and Kampa, Dr Elizabeth M Spectral Composition of the Luminescence of the Euphausiid *Thysanoessa raschii*, 1321
Bodenheimer, Prof F S *Obituary* by Dr B P Uvarov, 937
Bodies Psittacosis Elementary (F L Constable), 473
Bodies of Nissl and Neurofibrillae of the Locust, *Schistocerca gregaria* Effect of Insecticides on the (Dr Tohamy A Moussa and M Banhawy), 915
Bodies (Fat-free Carcasses and) of New Zealand Sheep Composition of some (A H Kirton, M J Ulyatt and R A Barton), 1724
Body Burdens (Maximum Permissible), and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure (United States National Bureau of Standards, Handbook 69), 939
Body Temperature in Hibernating Bats Endogenous Rhythms of (Prof Michael Menaker), 1251
Body-Weight Effect of Thioctic Acid on Gain in, by Turkey Poults (J R Jowsey, R M Blakeley and H I MacGregor), 1323
Boehm, Rudolf (herausgegeben von) Theorie der Phanomenologischen Reduktion (Erste Philosophie, 1923-24 (Edmund Husserl), Teil 2), (Husserliana Band 8) *review* by F I G Rawlins, 1751
Boeri E , and Brighenti, L Structure and Chemistry of Proteins (Inhibition of several —SH Enzymes by 'Sulphanilamide Disulphides'), 1277
Bogoch, Dr Samuel Glycoproteins of Human Cerebrospinal Fluid, 1628
Boguslawska-Jaworska, J , and others Regeneration of Protein from Insoluble Protein-Tannin Compounds, 1799
Bohlken, H At the Conference of the Mammal Society of the British Isles (Findings on the Stomachs of the Tylopoda), 30
Bohus G , and others A New Trichothecin-like Antifungal Antibiotic, 908
Boisson J (Tavernier, P , and) Chemistry of Propellants (Solid Propellants—Composite Forms), 779
Bokkenheuser, V , and Koornhof, H J Interaction of Erythrocytes and Endotoxins, 109
Boksenberg, A (Boyd, R L F , and) Ionization Phenomena in Gases (Measurements of Ionization Cross-section of Electrons in H), 1354
Bolam, Francis (edited by) Fundamentals of Paper-making Fibres—Transactions of the Symposium held at Cambridge, 1957, *review* by Dr Julius Grant, 1011
Bolcato, V , and Leggiero, G Glycolaldehyde Trapped from Aerobic Oxidation of D-Xylose by *Torulopsis utilis*, 1318
Bolinopsis infundibulum (O F Muller) Feeding of a Ctenophore (A K Nagabhushanam), 829
Bolling, G F Recrystallization of Zone-Refined Lead, 718
Bolshaya Sovietskaya Enziclopediya, Vol 50, 857, 1451
Bolton, J R , and McCallum, Prof K J Szilard-Chalmers Reaction in Lithium Permanganate, 1717
Bond, J W Basic Problems in Propulsion (Electromagnetic and Nuclear Thermal Propulsion) 779
Bond, Roy D Occurrence of Microbiological Filaments in Soils, 744
Bond, R L , and Spencer, D H T Coal Science (Sorption Data obtained with Inert Gases on Coal and of Heats of Wetting of Coal in Polar Liquids), 412
Bond, R L , and others Studies of Coal—Carbonization of Coals in the Presence of Activated Charcoal, 425
Bond Energies of Carbon–Carbon Single Bonds Effect of Hybridization Changes on the (J E Bloor and S Gartside), 1313
Bondi, Prof H The Steady-Rate Universe and the Deduction of Continual Creation of Matter, 537
  Thermonuclear Research (Magnetostatics), 1017
  Series of astronomical articles in the *Illustrated London News*, 1913
Bondi, Prof H , and Lyttleton, Dr R A A Comparison of Charges on the Electron, Proton and Neutron, 974

Bonds (Carbon–Carbon Single) Effect of Hybridization Changes on the Bond Energies of (J E Bloor and S Gartside), 1313
Bonds (Carbon-Oxygen), in some Aromatic Compounds Hydrogenolysis of, by Electrolysis (Dr P H Given and Dr M E Peover), 1064
Bone, Dr D H Glutamic Dehydrogenase of Mung Bean Mitochondria, 990
Bone, Quentin (Wickstead, J H, and) Ecology of Acraniate Larvae, 1849
Bone Fractures Urinary β-Glucuronidase Activity in Patients with (F J W Lewis and Dr Constance H J Plaice), 1249
Bone (Compact) Distribution of Sodium in, as revealed by Autoradiography of Neutron-activated Sections (Prof J Vincent), 1332
Bone Implement from Sterkfontein (Dr J T Robinson), 583
Bone Marrow (Foreign), in Lethally X-Irradiated Mice Abrogation by Injected Mouse Blood of Protective Effect of (L J Cole and R M Garver), 1815
Bone Marrow (Guinea Pig) Cells which Synthesize Deoxyribonucleic Acid in, during Recovery from Whole-Body γ-Irradiation (P F Harris and J H Kugler) 1883
Bone Marrow Therapy Interstrain Ovarian Transplantation in Lethally Irradiated Mice after (Prof W St Amand and L H Smith), 1503
Bone Sarcoma in Man A Seasonal Rhythm in the Presentation of (Dr C H G Price), B A 76
Bone Tumours An Effect of Dose Fractionation on the Incidence of, using Radioactive Phosphorus (Dr N M Blackett), 565
Bones (Rabbit's Long) Glutamic-Pyruvic Transaminase in (L Tessari and L Parrini), 904
Bonner, Prof James Elected a member of the Botany Section of the Leopoldina Academy of Natural Sciences, 595
  Probable Future of 'Auxinology', 599
Bonner, Prof John Tyler The Cellular Slime Molds, *review* by D Park, 1976
Bonnetain, L, and others Coal Science (Energy of Activation of the Combustion of Graphite), 414
Book (Source), of Fungal Physiology, *review* by Dr J L Harley, 85
Booker, G R, and Norbury, J A New Nitride Precipitate in Iron-Silicon Alloys, 1311
Books Recent Scientific and Technical, Supp v, July 25, Supp iv, August 29, Supp v, September 26, Supp iv, October 31, Supp vi, November 28, Supp iv, December 26
Books (British), and Foreign Markets, 605
Books (Technical), sponsored by the United States Atomic Energy Commission, 407
Books and Films (British) Distribution of, Overseas, 1448
Books and Periodicals (British) Exhibition in Moscow of (British Council and the Soviet Ministry of Culture), 1361
Boophilus decoloratus Contents of Cystine-Cysteine, Glutathione and Total Free Sulphydryl in Arsenic-resistant and Sensitive Strains of the Blue Tick (Dr J S Harington), 1739
Boos, G M E Oil Pollution of the Sea (Functions of the International Convention for the Prevention of Pollution of the Sea by Oil taken over by the Inter-governmental Maritime Consultative Organization), 950
Booth, Capt C F Appointed a deputy engineer-in-chief in the General Post Office, 1531, work of, 1532
Booth, Dr V H Food Analysis, *review*, 1347
Boots' New Biological Research Laboratories (Dr G I Hobday), 1274
Borazole Substituents Intermolecular Distances and Diamagnetic Anisotropy in Crystals as Measures of the Polarity of Benzene and (Dame Kathleen Lonsdale), 1060
Borden Award of the Nutrition Society of Canada, 507
Bordetella pertussis Formation of the Toxoid of Histamine Sensitizing Factor in (Prof Toshitaka Matsui and Yoshio Kuwajima), 199
Bore, C L Structural Effects of Kinetic Heating (Some Practical Aspects of Kinetic Heating Calculations), 31
Bore-Hole to the Earth's Mantle—AMSOC's Mohole (Gordon Lill and Willard Bascom), 140
Borgin, Dr K, and others Evidence for a Hydrate of Cellulose from Studies of its Surface Properties, 1561
Born, Max Elected an Honorary Member of the American Academy of Arts and Sciences, 409
Boron Isotopic Composition of (D C Newton, A C Tyrrell and J Sanders), 185
Boron Nitride (Cubic) Transformation of a, to a Graphitic Form of Hexagonal Boron Nitride (H Judith Milledge, E Nave and F H Weller), 715
Boron Nitride (Hexagonal) Transformation of a Cubic Boron Nitride to a Graphitic Form of (H Judith Milledge, E Nave and F H Weller), 715
Boron Phosphide and Nitride Synthesis of (Dr R C Vickery) 268
Boros, D L, and others Lowered Bactericidal Efficiency of Hydrogen Peroxide on Milk from Cows treated with Penicillin, 292
Borrelia duttoni Is the Multimammate Rat a Natural Reservoir of (Dr F Zumpt), 793
Borrell, Dr P A Correlation between the Shift in the Ultra-Violet Absorption Maxima and the Electronegativity of the Adjacent Atoms in some Aliphatic Carbonyl Compounds, 1932
Borrill, M Inflorescence Inception and Leaf Size in Gramineae, 321
Borst, P, and Slater, Prof E C Need for Inorganic Phosphate in Oxidations stimulated by Dinitrophenol, 1396
Borucka, Dr A Z Special Ceramics (Construction of a Furnace to give a Hot Zone of very Uniform Temperature), 1116
Borucka, Dr A Z (Cole, Dr M, and) Special Ceramics (Novel Replaceable Heating Element), 1116
Bos, C J (Emmelot, Dr P, and) Efficiency of the Mitochondrial Oxidative Phosphorylations in Intact Ascites Tumour Cells, 2024
Bos taurus and *Bos indicus* Beef Cattle A Possible Explanation for Part of the Difference in Heat Tolerance Exhibited by (H P Ledger), 1405
Bose (Sir J C) Premium of the British Institution of Radio Engineers awarded to Dr B Ramachandra Rao, Dr M Srirama Rao and C Abhirama Reddy, 857
Bose, Dr J L, and others Action of Manganese Dioxide on Simple Carbohydrates, 1301
Bose, Nanda Effect of Gibberellin on the Growth of Pollen Tubes, 1577
Botanic Garden (Brooklyn), and others Fourth International Conference on Plant Growth Regulation, 599
Botanic Gardens, Kew The Royal (Dr W B Turrill), *review* by Dr Richard A Howard, 1345
Botanic Gardens, Singapore, 1859-1959 (H M Burkill), 1602
Botanical Collections Further, 681
Botanical Congress Montreal Ninth International, 1200
Botanical Garden (New York) Resignation of Dr David D Keck as acting director, 680
Botanical Garden (New York), and others Fourth International Conference on Plant Growth Regulation 599
Botanical Laboratory New Australian, 1776
Botanical Society of Edinburgh Special number of the *Transactions* (Vol 38) published as a tribute to Prof J R Matthews on his seventieth birthday, 518
Botany African 594
Botany at Hull, 853
Botany in Scotland, 518
Botany (Agricultural), at Bangor, 502
Botany (Agricultural), at Leeds, 405
Botany (Agricultural), National Institute of Leaflets on Fodder Beet, Mangels and Swedes, 1777
Bothwell, P W Appointed lecturer in public health at the University of Bristol, 322
Botre, C, and others Influence of Counterion Association on the Configurational Stability of Deoxyribonucleic Acid in Solution, 1482
Bottomley, Dr W (Goldacre, Dr P L, and) A Kinin in Apple Fruitlets, 555
Bottomore, T B Title of reader in sociology in the University of London (at the London School of Economics and Political Science) conferred on, 508
Boughey, Prof A S Origin and Dispersal of Flowering Plants, 1200
Bouharmont, J Recherchés sur les Affinites Chromosomiques dans le Genre *Coffea*, 518
Boundary (The Upper), of the Van Allen Radiation Belts (Dr Conway W Snyder), 439
Boura, A L A, and others New Antiadrenergic Compounds, B A 70
Bourdier, Franck At the Museum National d'Histoire Naturelle's celebration of the anniversaries of the 'Precurseurs et Fondateurs de l'Evolutionnisme—Buffon, Lamarck, Darwin' 860
Bourke, Dr Ann (Longmuir, Dr I S, and) Application of Warburg's Equation to Tissue Slices, 634
Bourne, Dr D E Appointed lecturer in applied mathematics at the University of Sheffield, 410
Bourne, Prof E J (Bailey, R W, and) Formation of Leucrose in Dextran-producing Cultures of *Streptococcus bovis*, 904
Bourne, Prof E J, and others Interaction of Sucrose Stearate with Starch, 110
  Interaction of Anti-Staling Agents with Starch, 547
Bourne, Prof G H, and Danielli, Prof J F (edited by) International Review of Cytology Vol 7 *review* by Prof J Bronte Gatenby, 574
Bourne Prof G H, and others Effects of Irradiation of Nerve on Muscular Response, 734
Bourillon, Roland, and others Preparation of a Highly Purified Sample of the Urinary Gonadotrophin, 983
Bovenkerk, Dr H P, and others Preparation of Diamond, 1094
Bovet, D, and others (edited by) Curare and Curare-like Agents, *review* by Dr Marthe Vogt, 1093
Bovet-Nitti, F, and others (edited by) Curare and Curare-like Agents, *review* by Dr Marthe Vogt, 1093
Bovien, Prosper, and others Recognition of Diseases and Pests of Farm Crops, *review* by F C Bawden 1258
Bovine Liver Chromium Ribonucleoprotein from (Dr W E C Wacker and Dr B L Vallee), 1399
Bovine Stars of India (Indian Council of Agricultural Research, Misc Bulletin No 82), 941
Bovine Tissues (Rinderpest-infected) Heat Inactivation of (Dr G R Scott), 1948
Bovine Type Tubercle Bacilli Nicotinamidase in *Mycobacteria*—a Method for Distinguishing, from other *Mycobacteria* (Dr Kiyoshi Konno, Dr Hideo Nagayama and Dr Sutemi Oka), 1743
Bowden, Dr F P, and Yoffe, A D Fast Reactions in Solids, *review* by Dr Peter Gray, 664
Bowen Dr E J Energy Transfer with special reference to Biological Systems (Fluorescence Studies of the Excited Singlet States of Anthracene Derivatives), 689
Bower, Gail L, and others Macromolecular Components of *Chlorella pyrenoidosa*, 963
Bowhill, S A Fluctuation Phenomena in Stochastic Processes (Scattering of Electromagnetic Waves from a Continuous Medium containing Three-dimensional Random Inhomogeneities of Refractive Index), 511
Bowman, Dr J E (Walker, Dr D G, and) Glutathione Stability of the Erythrocytes in Iranians, 1325
Boxes (Glove), and Shielded Cells for Handling Radioactive Materials—a Report of the Proceedings of the Symposium on Glove Box Design and Operation held in the Cockcroft Hall, A E R E, Harwell, 1957 (edited by G N Walton), *review*, 1599
Boyd, Dr R L F Photography in the International Geophysical Year, 1032
Boyd, Dr R L F, and Boksenberg, A Ionization Phenomena in Gases (Measurements of Ionization Cross-section of Electrons in H), 1354
Boyd, Dr William C, and others Specific Inhibition of Anti-Rh Serum by 'Unnatural' Sugars, 989
Boyden, S V Delayed Hypersensitivity (Mechanism of the Tuberculin Reaction), 1029
Boyer, A F, and Payen, P Coal Science (Carbonization—Apparent Exothermic Peak found in Differential Thermal Analysis of certain Coals), 413
Boyer, Francis The Structure of Science, B A 6
Boyer, Paul D, and others (edited by) The Enzymes, Vol I, Kinetics, Thermodynamics, Mechanism, Basic Properties, second edition, *review* by Dr Edwin C Webb, 1759
Boyle's Air Pump Robert Hooke and (Dr H D Turner), 395
Boyo, Dr A E, and Hendrickse, R. G New Fast Abnormal Haemoglobin in Newborn Nigerians, 997
Boys (Charles Vernon) Prize Address to the Physical Society (Dr D A Glaser), 954
Bozian, Dr R C, and Touster, Prof Oscar Essential Pentosuria—Renal or Enzymic Disorder, 463

Braarud, Prof T Polar Front Survey (Hydrography—North Atlantic Ocean), 1182 , (Biology—Productivity of the Norwegian Sea), 1193
Brabazon Premium of the British Institution of Radio Engineers awarded to Prof D G Tucker, Dr V G Welsby, R Kendall and D E N Davies, 857
Braby, F C Elected chairman of the Council of the British Non-Ferrous Metals Research Association, 1273
Bracewell, Ronald D (edited by) Paris Symposium on Radio Astronomy, 1958, *review* by Dr H P Palmer, 1755
Brachet, Prof Jean Elected an Honorary Member of the American Academy of Arts and Sciences, 409
  Thiol Groups and Morphogenesis, 1074
Bracken Effects of Substituted Phenoxy-Compounds and other Translocated Herbicides on the Rhizome of (Dr Elsie Conway and J A Forrest), 1416
Bradbury, J H Structure and Chemistry of Proteins (Paper Chromatography of Dinitrophenyl Amino-Acids), 1277
Bradbury, Dr S Microscopes and Photomicrography, *review*, 1174
Bradford Chemical Society, and others Symposium on Recent Developments in Textile Chemistry, 1845
Bradford Institute of Technology Symposium on Organic-Phosphorus Compounds, 1688
  Course in New Techniques in High Polymer Chemistry, 1845
Bradford Institute of Technology, and others Symposium on Recent Developments in Textile Chemistry, 1845
Bradley, Dr D C , and Faktor, Dr M M Volatile Methoxides of Aluminium and Zirconium, 55
Bradley, Dr D F , and Felsenfeld, Dr G Aggregation of an Acridine Dye on Native and Denatured Deoxyribonucleates 1920
Bradshaw, A V Appointed to the University of London readership in extraction metallurgy at the Imperial College of Science and Technology, 1535
Bradshaw, F J Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 858 , work of, 858
Bradsher, Dr C K , and Dutta, Dr N L Berberine Alkaloids via 6,7-Dimethoxy*iso*quinoline-1-aldoxime, 1943
Braganca, Dr B M Awarded a grant by the Lady Tata Memorial Trust, for research on Leukaemia and allied Diseases, 507
Braganca, Dr B M , and Kenkare, U W Flavins as Components of Folic Acid Reductases, 1488
Bragg, Sir Lawrence Appointed Rutherford Memorial Lecturer for 1960, 26
  Elected an Honorary Member of the American Academy of Arts and Sciences, 409
Braid, Prof K W Conservation in the Scottish Highlands (The Rôle of Bracken in Highland Ecology), 1529
Brain, Sir Russell The Nature of Experience (Riddell Memorial Lecture), *review* by F I G Rawlins, 218
Brain Thermoregulatory Heat Production in the (Prof Sz Donhoffer, Gy Szegvari, I Jarai and M Farkas), 993
Brain Cortex *in vitro* Carbohydrate—Amino-Acid Inter-relations in (M M Kini and Prof J H Quastel), 252
Brain Glutathione (Rat), and Pyridoxine Deficiency (Dr M J Ashwood-Smith and A D Smith), 2028
Brain Tissue Presence of certain Onium Compounds in, following Intravenous Administration to Rats (Prof Ruth R Levine), 1412
Brain (Human) James Arthur Lecture on the Evolution of the—The Discrete and the Diffuse in Nervous Action (Prof D P C Lloyd), 1777
Brain (Rat) Increase in the γ-Aminobutyric Acid Content of, after Ingestion of Ethanol (Dr H -M Hakkinen and E Kulonen), 726
  Histochemical Study of Monoamine Oxidase in the Developing (Nobuo Shimizu and Nogaaki Morikawa), 650
  Noradrenaline and Adrenaline in the, during Acute and Chronic Morphine Administration and during Withdrawal (Dr Lars-M Gunne), 1950
Brain-Stem Stimulants (New) N-Substituted 7-Methoxy-8-Aminomethylchromones and Flavones— (P Da Re, L Verlicchi, Dr I Setnikar, W Murmann and M J Magistretti), 362
Brains (Mouse), infected with Tick-borne Encephalitis Virus Infectious Ribonucleic Acid from (F Sokol, H Libikova and J Zemla), 1581
Braithwaite, Prof R B Bertrand Russell, *review*, 749
  Knowing and Being, 1194
Brambell, Prof F W Rogers Appointed a member of the Agricultural Research Council, 508
Brande, Dr R Biological Problems arising from the Control of Pests and Diseases, 1102
Brandes, D , and others Effects of Irradiation of Nerve on Muscular Response, 734
Brannen, Dr E , and Wehlau, Prof W Polarization and Resolving Time Effects in Photon Correlation, 263
Bransden, Dr B H Nuclear Forces and the Few-Nucleon Problem (Reactions Involving Four or more than Four Nucleons), 1114
Braque, Georges Elected an Honorary Member of the American Academy of Arts and Sciences, 409
Brasted, Dr F Kenneth Has joined Texas Instruments, Inc , as administrative director of the Central Research Laboratory, 26
Brattain, Dr W H Transistors and Associated Semiconductor Devices, 693
Brayshaw, Dr G S Modern Network Theory in Electrical Engineering (Application of Positive-Real Graphs), 1692
Brazilian Centre for Physics Research Appeal by Unesco and the International Atomic Energy Agency for help to reconstruct the Library of the, 769
Brdicka, R Fast Chemical Reactions in Solution (Use of Polarographic Technique in the Study of Electrode Reactions), 1453
Breakage (Chromosome), with Plant Pigments (Dr Arun Kumar Sharma and Arati Gupta), 1821
Breccia, A , and others Rôle of Stroma in Haemoglobin Synthesis—Experiments on Duck Red Cells *in vitro*, 1878
  Pathway of Carbon-^{14} Incorporation from $NaH^{14}CO_3$ to Haem in Duck Blood incubated *in vitro*, 1879
Breder, Jr , Dr C M Studies on Social Groupings in Fishes, 865
Breed (Tropical), of Hair Sheep Light Regulation of Coat-Shedding in a (R B Symington), 1076
Breeding Habitat (An Unusual), of the Linnet (N W Orford), 650
Breger, I , and others Coal Science (Ultra-fine Structure of Coals and Chars), 413
Breit, Prof G Nuclear Forces and the Few-Nucleon Problem (The Primary Two-Nucleon Interaction), 1113 , (Photonuclear Reactions with Light Nuclei), 1114
Breitman, Dr Theodore R , and Webster, Dr George C Monovalent Cations and the Incorporation of Metabolites by Isolated Thymus Nuclei, 637
Breitwieser, R Chemistry of Propellants (Air-Burning Fuels—Deposits in Jet Engines), 779
Bremner, J M Soil Chemical Analysis, *review*, 1093
Brenan, J P M Flora of Tropical East Africa—Leguminosae subfamily Mimosoideae, 409
Brennen, D G Fluctuation Phenomena and Stochastic Processes (A New Approach to certain Types of Random Functions), 509
Bretherick, L , and others Congeners of Pempidine with High Ganglion-blocking Activity, 1707
Brewer's Yeast Effect of Oxygen on Endogenous Metabolism of a Respiratory-deficient (V E Chester), 1956
Brian, Dr P W Plant Growth Regulation (New Developments with the Gibberellins), 600
Brian, Dr P W , and others Extended Dormancy of Deciduous Woody Plants treated in Autumn with Gibberellic Acid, 69
Bridge Blood Anticoagulant Neutralization of (Dr F Nour-Eldin), 1419
Bridges, Dr C D B Visual Pigments of some Common Laboratory Mammals, 1727
Bridges, R G Pentachloro*cyclo*hexene as a Possible Intermediate Metabolite of Benzene Hexachloride in Houseflies, 1337
Bridges, R G , and Cox, J T Resistance of Houseflies to γ-Benzene Hexachloride and Dieldrin, 1740
Bridges, T , and Strnad, R Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Zone Melting of Single-crystal Sapphire Rod 0 1 in in Diameter), 692
Bridgman, Prof P W The Way Things Are, *review* by Prof C K Grant, 1975
Briggs, Dr B H Fluctuation Phenomena and Stochastic Processes (Experimental Problem of Specifying the Pattern on the Ground (including Time Changes and Movements) formed by Reflexion from, or Transmission through, an Irregular Ionosphere), 511
Brighenti, L (Boeri, E , and) Structure and Chemistry of Proteins (Inhibition of several —SH Enzymes by 'Sulphanilamide Disulphides'), 1277
Brightman, R A Defence of Free Learning, *review*, 576
  Automation and Society, *review*, 1438
  Development of Nuclear Power, *review*, 1673
Brill, Prof R , and Barth, H Intensity of the (III) Reflexion for Diamond, 264
Brinck, Per, and others (edited by) South African Animal Life—Results of the Lund University Expedition in 1950-1951, Vol 5, *review*, 133
Brindley, Prof G W Clay Minerals (Relationship between the Mineralogical Constitution and the Firing Properties of Clays), 779 , (Value of Electron Diffraction Techniques in Structural Investigations), 780
Brink, A B A , and others Pleistocene Climatic Significance of Calcretes and Ferricretes, 568
Brink of the Unknown (Lord Verulam), 1688
Brinkman, R Biological Effects of Low Doses of Ionizing Radiations (Techniques for Examining the Protective Effect of Chemicals against Radiation-induced Changes), 1112
Briquettes Compaction of (H R Gregory, D C Rhys Jones and J W Phillips), 120
Bristol City Museums Retirement of Dr F S Wallis from the directorship, 1685
  Appointment of Alan Warhurst as director, 1686
Britain Agricultural Research in, 238
  Building Research in, 1023
  Clerical Salaries in, 698
  Control of Government Research and Development Expenditure in, 696
  Divorce Statistics in, 1107
  Expansion of Educational and Training Facilities in, 569
  Expansion of University Education in, 1431
  Fundamental Research in, 1
  Handicapped Children in—their Problems and Education (compiled by W A Axford), (Library Association), 1777
  Industrial Research Associations in, 211, 238
  Industry and Health in, 1456
  Industry and the Technical Colleges in, 1690
  Inland Waterways in, 1687
  The Land of—is it Used to the Best Agricultural Advantage? (Association of Agriculture and the Extra-Mural Department of the University of London Lectures on), 1845
  The National Health Service in, 1201
  National Parks and Nuclear Power Stations in, 1005
  Nature Conservation and Youth Service in (Brigadier E F E Armstrong), 685 , (Edie J Green), 685
  Organization of Scientific and Technological Research in, 1255
  Phycology in, 1534
  Progress of Chemical Engineering in (Sir Hugh Beaver), 408
  Rediscovery of *Bathynella chappuisi* Delachaux in (Ian Efford), 558
  The School Health Service in, 98
  Science and the Library Services in, 1455
  Scientific Developments in, 1190
  Scientific Man-power Problems in, 1971
  Scientists in the Public Service in—Special Promotions, 858, 1273
  Scientists and Engineers in, 1982
  Secondary and Higher Education in, 1671
  Taxation of Learned and Professional Societies in, 1343
  Technological Education in, 94
  Underground Test Explosions in, 1532
  Universities and Adult Education in, 331
  See also under Great Britain
British Administration The Spirit of, and some European Comparison (C H Sisson), 128
British Agricultural History Society Winter Conference (G E Fussell), 1916
British Aid for NATO Scientific Courses, 406

INDEX

British Antarctic Party, 1985
British Association for the Advancement of Science Presidential Address, The Proper Study of Mankind is Man (Sir James Gray), B A 35
  Summaries of Addresses of Presidents of Sections, B A 41
  Presidential Address to Section A (Mathematics and Physics), The Visualization of Magnetic Processes (Prof L F Bates), B A 41
  Presidential Address to Section B (Chemistry), Medical Aspects of Complex Carbohydrates (Prof M Stacey), B A 42
  Presidential Address to Section C (Geology), Recent Developments and Trends in Palaeontology (Prof O M B Bulman), B A 42
  Presidential Address to Section D (Zoology), Man and the World's Fauna (Dr L Harrison Matthews), B A 43
  Presidential Address to Section E (Geography), Trends in Urban Expansion (Prof K C Edwards), B A 43
  Presidential Address to Section F (Economics), How Much Science ? (Prof J Jewkes), B A 44
  Presidential Address to Section G (Engineering), The Critical Importance of Transport and Communications (Sir Ewart Smith), B A 44
  Presidential Address to Section I (Physiology and Biochemistry), Artificial Organs—Biological Applications (Prof A Hemingway), B A 45
  Presidential Address to Section J (Psychology), Perception, Attention and Consciousness (Prof Magdalen D Vernon), B A 45
  Presidential Address to Section K (Botany), Plants on Land and in the Oceans (Dr W R G Atkins), B A 46
  Presidential Address to Section K*(Forestry), Pathogenic Factors in the Rooting Space and the Development of Even-Aged Plantations (W R Day), B A 46
  Presidential Address to Section L (Education), What are our Schools For ? (Sir James J Robertson), B A 47
  Presidential Address to Section M (Agriculture), Balance in British Farming (Dr H G Sanders), B A 48
  Election of Sir George Thomson as president for 1960, 151
  Section A (Mathematics and Physics) Discussion on Crystal Physics, 596
  Sections A (Mathematics and Physics) and H (Anthropology) Discussion on Radio-carbon Dating, 672
  Section B (Chemistry) Symposium on the Chemistry of Clothing, 849
  Section B (Chemistry) Discussion on Rocket Propulsion, 1264
  Sections B (Chemistry) and H (Anthropology) Discussion on Chemistry in the Preservation of Antiquities, 585
  Section D (Zoology) Symposium on the Evolution of Host-Parasite Relationships, 760
  Section D (Zoology) Symposium on Animal Clocks, 763
  Sections D (Zoology) and K (Botany) Symposium on Genetics and the Origin of Species, 587
  Sections E (Geography) and K (Botany) Discussion on Coast Erosion and Accretion, 499
  Section I (Physiology and Biochemistry) Discussion on Cell and Organ Culture, 935
  Section J (Psychology) Discussion on Chance and Probability, 497
  Section X (Assembly of Corresponding Societies) Meeting on Science by the Upper Form, 596
  To send two representatives (Dr W E Swinton and Sir George Allen) to the U S S R , 1271
British Association of British Rubber Manufacturers Publication of a translation of the Soviet journal *Kauchuk i Rezina* under the title *Soviet Rubber Technology*, 505
British Birds Resident (Educational Productions, Ltd , Filmstrip CX 6208), 1777
British Books and Films Overseas Distribution of, 1448
British Books and Foreign Markets, 605
British Books and Periodicals Exhibition in Moscow of (British Council and the Soviet Ministry of Culture), 1361
British Broadcasting Corporation Establishment of a Science Unit, 1361
British Caribbean, Regional Research Centre of the Soil and Land-Use Surveys, No 1, Parish of St Catherine, Jamaica (K C Vernon) , No 2, The Rupununi Savannas of British Guiana (R F Loxton, G K Rutherford and J Spector) , No 3, St Vincent (J P Watson, J Spector and T A Jones), 27
British Carnivores (R F S Creed), 1535
British Cast Iron Research Association Open Days (H Morrogh), 323
British Ceramic Research Association New Mellor Library opened by Frank West, 153
  Symposium on Special Ceramics, 1115
  Retirement of Dr A T Green from the directorship, 1843
  Appointment of Dr N F Astbury as director, 1843
British Coal Utilization Research Association (Staff of the) Studies of Coal —Carbonization of Coals in the Presence of Activated Charcoal (R L Bond, A M Godridge, A R Murnaghan, D H Napier and D J Williams), 425 , Smoke Emission from Coal and Low-Temperature Chars (D Finch), 426
British Coke Research Association (Coke Oven Managers' Association, the Institution of Gas Engineers and the) Joint Meeting, 1778
British Colonial Territories, 1541
British Committee (Joint), for Vacuum Science and Technology Formation of a, 1191
British Commonwealth, Association of Universities of the Commonwealth Universities Yearbook, 1959, *review*, 577
British Commonwealth Education Liaison Committee Establishment of a, 1361
British Computer Society First Conference (Dr A S Douglas), 945
British Contribution to High-Altitude Research, 1776
British Cotton Industry Research Association Fortieth Annual General Meeting, 1846
  Open Days at the Shirley Institute, 1846
British Council Scientific Research in British Universities (1958-59), 854
  Course on Digital Computers, 1450
British Council (Science Department) Third list of Nuclear Studies, 235
British Council and the Soviet Ministry of Culture Exhibition in Moscow of British Books and Periodicals, 1361
British East African Waters Black Marlin in (F Williams), B A 78
British Ecological Society Symposium on the Exploitation of Natural Animal Populations, 1451
British Electrical and Allied Industries Research Association (Prof J Greig), 1538
British Electronic Achievements, 943
British Embassy, Washington Appointment of Henry Edmunds as assistant agricultural and food attaché, B A 16
British Farming Balance in (Dr H G Sanders), B A 48
British Food Manufacturing Industries Research Association Open Days (Prof B R Knapp), 1275
British Forestry Commission Thirty-ninth Annual Report, 1457
British Gelatine and Glue Research Association Appointment of Dr D A Sutton as director of research, 318
  Seventeenth Meeting of the Research Panel (Alan G Ward), 862
  Discussion on Gelation, 863
British Glass Industry Research Association New Laboratories of the, 775
British Hat and Allied Feltmakers Research Association Annual Report (1957-58), 320
British Industries, Federation of Forty-second Annual Report (1958), 94
British Industries, Federation of (Liverpool District) Conference on the Relationship between Industry and Technical Colleges, 1690
British Industry, *review* by Prof A J Brown, 1089
British Industry The Structure of, a Symposium (edited by Duncan Burn), *review* by Prof A J Brown, 1089
British Institute of Management Cost of Labour Turnover, 1110
British Institute of Management and the Ministry of Labour Conference on Relationships in Industry—some Changing Concepts of Management, 156
British Institution of Radio Engineers Clerk Maxwell Premium awarded to C Powell and D A Hendley, 857
  Heinrich Hertz Premium awarded to K Foster, 857
  Sir Louis Sterling Premium awarded to Dr A van Weel, 857
  Sir J C Bose Premium awarded to Dr B Ramachandra Rao, Dr M Srirama Rao and C Abhirama Reddy, 857
  Brabazon Premium awarded to Prof D G Tucker, Dr V G Welsby, R Kendall and D E N Davies, 957
  Marconi Premium awarded to Dr Morton B Prince and M Wolf, 857
British Iron and Steel Research Association—London Group Laboratories Open Days (D U Hunt), 1536
British Isles Excursion Flora of the (Prof A R Clapham, Prof T G Tutin and Dr E F Warburg), *review* by P Falk, 1093
  Land and Water Bugs of the (Dr T R E Southwood and Dennis Leston), *review* by W J Le Quesne, 1977
British Mammals and some Others (Dr J F D Frazer), 29
British Medical Association The Life and Times of Sir Charles Hastings, Founder of the (Dr William H McMenemey), *review* by Dr W R Bett, 923
British Museum (Natural History) Accommodation given to the International Commission on Zoological Nomenclature, 156
  Bulletin, Geology, Vol 4, No 1, A Contribution to the Odontology of *Oreopithecus* (P M Butler and J R E Mills), 682
  Bulletin, Historical Series, Vol 1, No 6, Some Eighteenth Century Bird Paintings in the Library of Sir Joseph Banks (1743-1820), (Averil Lysaght), 941
  Some Additions to the (Sir Gavin de Beer), 1682
  Return of Dr G H Francis and Dr A J Charig from their Expedition to South Peru, 1687
British Neutron Source Thermal Reactor, 1533
British Non-Ferrous Metals Research Association New Research Laboratories, 234, 242
  Election of F C Braby as chairman of the Council, 1273
British Nuclear Energy Conference (Institution of Electrical Engineers and the) Convention on Thermonuclear Processes, 240
British Occupational Hygiene Society Eleventh Conference (Heating and Ventilation), 1987
British Overseas Information Services, 1692
British Paint, Colour and Varnish Manufacturers, Research Association of Retirement of Dr L A Jordan as founder-director, 852
British Parasitic Fungi (W C Moore), *review* by Dr Lilian E Hawker, 1977
British Petroleum Trading, Ltd Grant of £3,000 to the University of Oxford, for the purpose of continuing a research fellowship in geochemistry, 1688, 1986
British Rayon Research Association Open Days (L A Wiseman), 600
British Rubber Manufacturers, Research Association of Publication of a translation of the Soviet journal *Kauchuk i Rezina* under the title *Soviet Rubber Technology*, 505
British Scientific Instrument Research Association Changes in the publications, 320
  To produce an English translation, under the title *Instrument Construction*, of the Russian journal *Priborostroenie*, 592
British Seas *Acanthocottus liljeborgi* (Collett) in (P J Miller), 1162
British Society for Immunology Symposium on Delayed Hypersensitivity, 1029
British Society for the Philosophy of Science Fourth Annual Conference, 1193
  Symposium on Scientific Research and the Philosophy of Science, 1193
  Symposium on Biology and Physics, 1193
  Symposium on Classification, Concept-formation and Language, 1193
  Symposium on Knowing and Being, 1193
British Society of Rheology Election of Officers for 1959-60, 943
  Meeting in Manchester, 1535
British Society of Rheology and the Colloid and Biophysics sub-Committee of the Faraday Society Discussion on Flow Properties of Blood and other Biological Systems, 322, 1539
British Society of Soil Science Discussion on Availability of Plant Nutrients, 159
British Space Research, 24
British Universities Scientific Research in, 1958-59 (British Council), 854
British Universities Film Council Twelfth Annual General Meeting (Dr J Horne), 330
  Discussion on the Visual Illustration of University Lectures, 515
British Welding Research Association and the Engineering Department of the University of Cambridge Symposium on Fatigue of Welded Structures, 1915
Brittain, Dr Robert Rivers and Man, *review* by Dr E H Brown, 1977
Broad, E R Modern Network Theory in Electrical Engineering (Place and Teaching of Electrical Network Theory in Universities and Technical Colleges), 1692

Broad Bean (*Vicia faba* L) Glyceric Acid in (R I Morrison and Dr P C Dekock), 819
Broadbent, Dr D E Ergonomics, its Place in Industry, B A 21
  Recent Studies of Noise Problems (Human Response to Noise—Effects of Noise on Working Efficiency), 414
Broadbent, Prof T A A Differential Equations for Instrumentation Engineers, *review*, 6
  Puzzle-Math, *review*, 217
  Selections from Modern Abstract Algebra *review*, 301
  Numerical Analysis and Partial Differential Equations, *review*, 576
  Introduction to Functional Analysis, *review*, 666
  Fourier Series, *review*, 1176
Broadcasting Two Threats to—Political and Commercial Control (H Carleton Greene), 661
Broadcasting and Television Future of, 1747
Broadening (Collision) of Spectral Lines, 155
Broadfoot, W C, and others Biosynthesis of some Amino-Acids from Sucrose by Germinating Uredospores of Wheat Stem Rust, Race 15B, 1943
Broadhead, C H Personnel Management and Technological Change (Growth, Development and Possible Extension of Personnel Management in British Industry), 1614
Broadhurst, Dr P L Application of Biometrical Genetics to Behaviour in Rats, 1517
Broccoli Floral Abnormalities in (D R Sampson and M MacArthur), 682
Brod, Dr J, and others Haemodynamics in Essential Hypertension, 1643
Broda, Prof E, and others Production of Serum Albumin and of Globulins by Chick Mesenchymal Tissue and by HeLa Tumour Tissue in Culture, 361, *erratum*, 943
Brody, Dr S S Fast Chemical Reactions in Solution (Direct Measurement of Energy Transfer Processes), 1454
Brody, Dr S S (Rabinowitch, Prof B, and) Energy Transfer with special reference to Biological Systems (Energy Migration in Photosynthesis), 689
Broggi, Prof J A Elected to foreign membership of the Geological Society of London, 1360
Bromide Ion A Peripheral Effect of the, on the Contraction of Striated Muscle (Dr D K de Jongh and H A Linnewiel), 1240
5-Bromouracil Incorporation of, into Transforming Principle of *Bacillus subtilis* and its Biological Effects (Dr Erela Ephrati-Elizur and Prof Stephen Zamenhof), 472
Bronchodilator Alkaloid (Vasicicone) from *Adhatoda vasica* Nees (A H Amin and D R Mehta), 1317
Brongersma, Dr L D The Animal World of Netherlands New Guinea, *review* by J E Hill, 1261
Bronk, Dr Detlev W A University of Graduate Studies, 86
  The Structure of Science, B A 6
  Special Medal of the Society for Promoting International Scientific Relationships awarded to, 1685
Brood Parasitism (Avian) Prolactin in the Cowbird's Pituitary in relation to (Prof E O Hohn), 2030
Brooke, Marcus S, and others Inhibition of Urease by Alloxan and Alloxanic Acid, 1936
Brookes, A M P Visual Illustration of University Lectures, 516
Brooklyn Botanic Garden, and others Fourth International Conference on Plant Growth Regulation, 599
Brooks, C E Ergonomics, its Place in Industry, B A 21
Brooks, H (edited by) Advances in Semi-Conductor Science—Proceedings of the Third International Conference on Semi-Conductors, Rochester, 1958, *review* by Dr J R Tillman, 1674
Brooks, Dr John R, and others Maintenance of Parathyroid Tissue Fragments on Agar Substrates, 1734
Brown, Ann, and others Effect of Oxygen Tension on Haem and Porphyrin Biosynthesis, 1217
Brown, Prof A J British Industry, *review*, 1089
  New Ideas for Industry, *review*, 1348
Brown, Dr E H Rivers and Man, *review*, 1977
Brown, F, and Stewart, Doreen L Effect of Proflavine on the Formation of Virus of Foot-and-Mouth Disease and its Infective Ribonucleic Acid in Pig Kidney Tissue Culture Monolayers, B A 74
Brown, Prof F A Animal Clocks, 763
Brown, F B, and others Coal Science (Chemical Reactions of Coal—Phenolic Hydroxyl in Vitrains), 412
Brown, Dr F H, and others Energy Transfer with special reference to Biological Systems (Electronic Energy Transfer in Solution), 689
Brown, G, and Stephen, Dr I Clay Minerals (Studies on Iddingsite), 780
Brown, Dr G E Title of professor of mathematical physics in the University of Birmingham conferred on, 679, work of, 679
Brown, Dr J K Appointed lecturer in chemistry at the University of Birmingham, 1362, 1688
Brown, Dr J K, and others Coal Science (Data obtained on Coal by High-resolution Magnetic Resonance Spectroscopy), 412
Brown, Paul K, and others Photochemical and Stereochemical Properties of Carotenoids at Low Temperatures—*Cis-trans* Isomerism and Steric Hindrance, 617
Brown, Patricia S, and others Isomers of Vitamin A in Fish Liver Oils, 1377
Brown, Dr Raymond A The Structure of Science (Properties of Deoxyribonucleic Acid), B A 9
Brown, Dr R R, and others 8-Hydroxyquinaldic Acid, the Red Fluorescent Substance in the Urine of Pyridoxine-deficient Rats, 1573
Brown, S C Ionization Phenomena in Gases (High Frequency Waves in Ionized Gases) 1357
Brown, Dr W M Court, and others Dose-Response Relationship in Radiation Leukaemia, 1669
Brown and Yellow Adipose Tissue of the Bat Lipase Activity in the (Prof J C George and J Eapen), 59
Brown Ear Tick, *Rhipicephalus appendiculatus* Neumann New Cell Types in the Salivary Glands of the (Dr W M Till), 1078
Brownwell, Dr P At the Second Australian Spectroscopy Conference (Analysing for Very Small Quantities of Sodium, a Micro-nutrient for *Atriplex vesicaria*), 1197
Broyde, Dr Barret (Oster, Prof Gerald, and) A Sensitive Chemical Dosimeter for Ionizing Radiation, 545
Bruce, Dr C E R The Temperature required for Nuclear Reactions in Cosmical Electrical Discharges, 2004
Bruce, Hilda M An Exteroceptive Block to Pregnancy in the Mouse, 105
Bruce, Dr V G, and others Growth Patterns in *Neurospora*—A Biological Clock in *Neurospora*, 169
Brucella Organisms Bacteriophage Typing applied to Strains of (Prof G C van Drimmelen), 1079
Brucer, Dr Marshall (compiled by) The Acute Radiation Syndrome—a Medical Report on the Y-12 Accident, 1958 (United States Atomic Energy Commission, Report ORINS-25), 1022
Brucker, R, and others Coal Science (Carbonization—Studies of the Maceral Species Exinite and Vitrinite by Pyrolysis under High Vacuum), 413
Brueckner, Prof K A Nuclear Forces and the Few-Nucleon Problem (The Primary Two-Nucleon Interaction), *1113*, (The Hartree-Fock Method for Strongly Interacting Systems), 1114
Brûlure L'Auto-Intoxication apres (R Godfraind), *review* by Dr S Sivett, 5
Brundrett, Sir Frederick Retirement as scientific adviser to the Ministry of Defence and chairman of the Defence Research Policy Committee, 1105, work of, 1105
Brunsting, J R, and others Intravascular and Intracardiac Blood Velocity Patterns recorded by means of *NTC* Resistors, 991
Brush-tailed Opossum *Trichosurus vulpecula* in New Zealand Bionomics of the (R I Kean), 1388
Bryant, Dr F J Appointed lecturer in physics at the University of Hull, 1273
Bryant, Dr F J, and others Strontium-90 in the Australian Environment, 1957-58, 755
Bryant P R Modern Network Theory in Electrical Engineering (Topological Analysis of the Order of Complexity of an Electrical Network), 1691
Bryen, F At the first Conference of the British Computer Society (Application of Punched Card Machinery to Factory Control), 946
Bubble Chambers Development of, and some recent Bubble Chamber Results in Elementary Particle Physics (Dr D A Glaser), 954
Bubble Counting on Low-Energy Particle Tracks (I R Birss), 1474
Buchanan, Dr J G, and others Teichoic Acids from Bacterial Walls—Composition of Teichoic Acids from a Number of Bacterial Walls, 247, Structure of Teichoic Acid from the Walls of *Bacillus subtilis*, 248
Buchanan-Davidson, D J, and others Immunochemical Studies of Polypeptidyl Proteins and Synthetic Polypeptides, 549
Buchdahl, Gerd Conceptual Foundations of Science, *review*, 572
  Classification, Concept-formation and Language, 1194
  The History of Western Thought, *review*, 1829
Bucherl, Wolfgang Kritische Untersuchungen der Newportia-Arten (Beitrage zur Neotropischen Fauna) *review* by Dr F A Turk, 1177
Buckle, E R Thermodynamics (Phase Changes in Condensed Systems), 1609
Budrikis, Z L (Seyler, A J., and) Measurements of Temporal Adaptation to Spatial Detail Vision, 1215
Buerger, Prof Martin J Twinning of Crystals, 1910
Buerger, Prof Martin J (Azaroff, Prof Leonid V, and) The Powder Method in X-Ray Crystallography, *review* by Prof H Lipson, 1599
Buffaloes of India Cattle and, 941
Buffer Systems (Suitable), for Counter-current Distribution A Paper-Chromatographic Method for the Determination of (Andrzej Waksmundzki and Edward Soczewinski), 977
Bugher, J G, and others (edited by) Biological Sciences, Vol 2 (Progress in Nuclear Energy, Series 6), *review* by Prof G Pontecorvo, 1902
  Medical Sciences, Vol 2 (Progress in Nuclear Energy, Series 7), *review* by Dr N M Blackett, 1766
Bugs (Land and Water), of the British Isles (Dr T R E Southwood and Dennis Leston), *review* by W J Le Quesne, 1977
Building Industry Incentives in the (Alison Entwistle and W J Reiners), (Building Research Station, National Building Studies Special Report No 28), 98
Building Research in Britain, 1023
Building Research Board Report of the, with the Report of the Director of Building Research (Department of Scientific and Industrial Research), 1023
Building Research Bureau Establishment of a (New Zealand Master Builders' Federation and the New Zealand Institute of Architects), 235
Building Research Station National Building Studies Special Report No 28, Incentives in the Building Industry (Alison Entwistle and W J Reiners), 98
Buildings (Ancient), Society for the Protection of (Central Council for the Care of Churches and the) Report on the Conservation of English Wall-paintings, 1119
Bulbing of Onions Auxin and the (Dr J E Clark and Prof O V S Heath), 345
Bull, P C A Seasonal Sex Difference in the Infestation of Rabbits with the Nematode *Trichostrongylus retortaeformis* (Zeder, 1800), 281
Bullard, Sir Edward Elected a foreign associate of the United States National Academy of Sciences, 95
  Charles Chree Lecture of the Physical Society, 954
Bullivant, J S Stomach Contents of Spawning Quinnat Salmon, 71
  An Oceanographic Survey of the Ross Sea, 422
Bulman, Prof O M B Recent Developments and Trends in Palaeontology (Presidential Address to Section C (Geology) of the British Association for the Advancement of Science), B A 42
Bumblebees (Dr John B Free and Dr Colin G Butler), *review* by Dr M Delia Allen, 1178
Bundy, Dr F P, and others Preparation of Diamond, 1094
Bunsengesellschaft fur Physikalische Chemie (Deutsche), and the Max-Planck Gesellschaft Colloquium on Fast Chemical Reactions in Solution, 1453
Bunsen Gesellschaft fur Physikalische Chemie (Deutsche), and the International Union of Pure and Applied Chemistry Symposium on Thermodynamics, 1606
Buoyancy of the Cuttlefish (Dr E J Denton and Dr J B Gilpin-Brown), 1330
Buoyancy in relation to the Ecology of the Freshwater Phytoplankton (Dr J W G Lund), 1534
Burbridge, Dr R F Lectureship in electrical engineering in the University of Bristol conferred on, 410

Burch, R L (Russell, Dr W M S, and) The Principles of Humane Experimental Technique, *review* by Prof M Weatherall, 1675
Bureau de Recherches Geologiques, Geophysiques et Minieres (Service d'Information Geologique) A New Geological Documentation Service, 153
Bureau Central International de Seismologie Report of the Meetings of the Section for Seismology and the Physics of the Earth's Interior (Dr Markus Båth), 154
Burge, Dr R E, and Hynes, R D The Optical Rotatory Power of Collagen, 1562
Burgen, Dr A S V Self-Regulation in Living Systems, 239
Burges, H D Dormancy of the Khapra Beetle—Quiescence or Diapause, 1741
Burgess, Dr G H O The Torry Research Station, Aberdeen, 863
Burgess, L Probing Behaviour of *Aedes aegypti* (L) in Response to Heat and Moisture, 1968
Burgess, Prof R E, and others (edited by) Progress in Semiconductors, Vol 3, *review* by Dr R A Hyman, 1754
Burke, Dr P G Nuclear Forces and the Few-Nucleon Problem (Binding Energies and Elastic Scattering of Light Nuclei at Low Energies), 1114
Burkill, H M The Botanic Gardens, Singapore, 1859-1959, 1602
Burkitt, M C Indian Prehistory, *review*, 131
Burley, R W, and Horden, F W A Experiments on Wool from Copper-deficient Sheep, 1725
Burma, Dr D P Pentose Phosphate Metabolism, 1368
Burma, Dr D P (Basu, D K, and) Biochemical Research in India (Detection and Purification of a Stereo-specific Dihydrolipoic Acid Dehydrogenase), 1368
Burma, Dr D P (Chakravroty, M, and) Biochemical Research in India (Microbial Synthesis of Protein in relation to the Biogenesis of Nucleic Acids), 1367
Burn, Duncan (edited by) The Structure of British Industry, a Symposium, *review* by Prof A J Brown, 1089
Burn, Prof J H, and Rand M J Sympathetic Postganglionic Mechanism, 163
Burnet, Sir Macfarlane The Clonal Selection Theory of Acquired Immunity (Abraham Flexner Lectures of Vanderbilt University, 1958), *review* by Dr J H Humphrey, 753
Awarded the Copley Medal for 1959 of the Royal Society, 1189, 1833, work of, 1833
Burnet, Sir Macfarlane, and others Failure to Recover Infective 'Ribonucleic Acid' from Myxovirus Preparations, 360
Burney, Dr Leroy The Structure of Science, B A 6
Burning Toxaemia after, *review* by Dr S Sevitt, 5
Burns, Dr J J (Conney, Dr A H, and) Stimulatory Effect of Foreign Compounds on Ascorbic Acid Biosynthesis and on Drug-Metabolizing Enzymes, 363
Burns, Prof W Recent Studies of Noise Problems (Human Response to Noise—Noise and Hearing Loss), 414
Burr, Jr, John G Tracer Applications for the Study of Organic Reactions, *review* by Dr A I Scott, 1902
Burris, R H, and others Oxidative and Phosphorylative Activities of Cytoplasmic Particles from Plant Tissue Cultures, 1491
Burry, Harris S Resistance to Flow in Vascular Beds, 453
Burstall, Prof A F *Obituary* of Prof A Preece, 316
Bursting Pressure Measurement of the Effects of Piston Mass and, on the Motion of a Piston in a Hypersonic Gun Tunnel (B J Belcher), 1207
Burstone, Dr M S Histochemical Localization of Oxidase Activity in the Mitochondria of the Human Heart, 476
Bursts (Slow-Drift Solar Radio) Geomagnetic Disturbance and Velocity of (M B Wood and C S Warwick), 1471
Burton, Dr A C Self-Regulation in Living Systems (Interaction between Visual Inputs), 240
Burton, Prof D, and others A New Approach to the Dating of the Dead Sea Scrolls, 533
Burton, Eileen Science by the Upper Form (The Seasonal Rhythm and Behaviour of the Birds of Bempton Cliffs), 597
Burton, J F, and Cain, B F Antileukaemic Activity of Polyporic Acid, 1326
Burton, L K, and others Current Trends of Strontium-90, Strontium-89 and Caesium-137 Levels in Milk, 89
Burton, Dr Maurice Phoenix Re-born, *review* by T H Hawkins, 665
Burton, Prof M, and Dreeskamp, H Energy Transfer with special reference to Biological Systems (Measurement of Luminescence Decay Times in Scintillator Systems), 689
Fast Chemical Reactions in Solution (Direct Measurement of Energy Transfer Processes), 1454
Burton, M A (Ellis, Dr J R, and) Sterility in *Lathyrus odoratus* L, 204
Burton, Vivian, and others Fluorescent Schiff-Type Reagents for Cytochemical Detection of Polyaldehyde Moieties in Sections and Smears, 1797
Burtt, Dr E T Animal Clocks, 765
Busemann, Dr Felix *Obituary* by L Gosland, 150
Bush, I E Biosynthesis and Secretion of Adrenocortical Steroids (Chemical Nature of Adrenocortical Steroids), 415
Bush, J A, and Wilson, Prof P W A Non-Gummy Chromogenic Strain of *Azotobacter vinelandii*, 381
Bushmen and some other South African Peoples Haptoglobin and Transferrin Variants in (Dr N A Barnicot, J P Garlick, Ronald Singer and Dr J S Weiner), 2042
Business Machines Corporation, International Appointment of Dr Carl F Kossack as manager of the newly formed Statistics and Operations Research Department at the Lamb Estate Research Center, Cortlandt, N Y, 410
Busvine, Dr J R Biological Problems arising from the Control of Pests and Diseases (Insect Resistance to the New Synthetic Insecticides), 1102
Butland, A N P, and Crossley, P A Science by the Upper Form (Some Scientific Aspects of the River Ouse), 597
Butler, Dr C G Animal Clocks (Time-Sense of the Honey-Bee), 764
Butler, Dr C G (Frees, Dr John B, and) Bumblebees, *review* by Dr M Delia Allen, 1178
Butler, Dr C G, and others Extraction and Purification of 'Queen Substance' from Queen Bees, 1871
Butler, D S At the first Conference of the British Computer Society (Application of Fast Machines to Problems in Supersonic Flow-past Aerofoils and other Surfaces), 946
Butler, Dr H E Photography in the International Geophysical Year (Ultra-violet Astronomy of the Stars), 1032
Butler, Prof J A V Inside the Living Cell, *review* by Dr W L Sumner, 134
Energy Transfer with special reference to Biological Systems (Energy in the Biological Systems—Properties of Adenosine Triphosphate), 690
Butler, Prof J A V, and Katz, Prof B (edited by) Progress in Biophysics and Biophysical Chemistry, Vol 9, *review* by P A Merton, 1092
Butler, Prof J A V, and Robins, Dr A B Flow Properties of Biological Systems (Simple Viscometric Measurements (using Concentric Cylinders) for the Study of Nucleic Acid Solutions), 1540
Butler, P M, and Mills, J R E A Contribution to the Odontology of *Oreopithecus*, 682
Butler, Dr S T *Obituary* of Dr M R Schafroth, 403
Appointed to the chair of theoretical physics in the University of Sydney, 1447, 1911, work of, 1447
Butt, W D Awarded a Stothert Research Fellowship by the Royal Society, 595
Butterworths Scientific Publications, Ltd Publication of *Polymer*, a Journal to promote the Science of Large Molecules, B A 16
Buttiker, W Blood-feeding Habits of Adult Noctuidae (Lepidoptera) in Cambodia, 1167
Buttrose, Dr M S (Frey-Wyssling, Prof A, and) Photosynthesis in the Ear of Barley, 2031
Buxton, E W Production of a Perfect Stage in a Nutritionally Deficient Mutant of Pathogenic *Fusarium oxysporum* after Ultra-violet Irradiation, 1258
Buyle-Boden, M Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Byford, G H Eye Movement Recording, 1493
Bygdeman, M, and Stjärne, L Effects of 1,4-Dihydrazinophthalazine on Organ Content and Adrenal Medullary Secretion of Catechol Amines, 1646
Bynum, Barbara S (Shack, Joseph, and) Determination of the Interaction of Deoxyribonucleate and Magnesium Ions by means of a Metal Ion Indicator, 635
Byrne, J J Appointed chief of the Rural Economy Division of An Foras Talúntais (The Agricultural Institute), Dublin, 29, work of, 29
Buzzati-Traverso, A A (edited by) Perspectives in Marine Biology, Symposium held at Scripps Institution of Oceanography, 1956, *review* by Dr J A Allen, 215

CACAO Plants Deficient in Copper Swellings on the Shoots of (Dr R G Lockard, P Vamathevan and S Thamboo), 75
Cactaceae Die (Curt Backeberg), Band 1, Einleitung und Beschreibung der Peireskioideae und Opuntioideae, Band 2, Cereoideae (Hylocereae—Cereae, Austrocereinae), *review* by N Y Sandwith, 1010
Cacti, *review* by N Y Sandwith, 1010
Caddock, B D, and Davies, P L Use of Tritium to Study the Solubility of Water in Hydrocarbons, 2011
Cadman, Dr C H (Harrison, Dr B D, and) Rôle of a Dagger Nematode (*Xiphinema* sp) in Outbreaks of Plant Diseases caused by Arabis Mosaic Virus, 1624
Cadmium Sulphide Structure of Precipitated, as studied by Single-Crystal Electron Diffraction Pattern (Dr Ryoitiro Sato), 2005
Caesium Removal of Strontium and, from Milk (Dr B B Migicovsky), 374
Caesium in Terms of U T $+\Delta T$ An Error in the Determination of ΔT from the Lunar Ephemeris and the Frequency of (C A Murray), 441
Caesium-137 Concentration of, in the Coastal Waters of Japan, 1959 (Noboru Yamagata), 1813
Translocation of Cobalt-60 and, by Fungi in Agar and Soil Cultures (Dr Erna Grossbard and Dr D R Stranks), 310
Caesium-137 Levels (Strontium-90, Strontium-89 and), in Milk Current Trends of (W Anderson, L K Burton and J O Crookall), 89
Caesium Frequency and Time Standard An improved (Dr L Essen and J V L Parry), 1791
Caféier robusta (*Coffea canephora* Pierre) Recherches sur l'Autosterilite du (M Devreux, G Vallaeys, P Pochet et A Gilles), 518
Caffrey, Prof M *Obituary* by Prof R McKay, 1359
Cagniard de la Tour, Charles (1777-1859), 24
Cain, Dr A J Die Banderschnecken, eine Studie zur Evolution der Tiere, *review*, 390
Cain, B F (Burton, J F, and) Antileukaemic Activity of Polyporic Acid, 1326
Cain, John From Tinfoil to Tape—the History of the Gramophone (Christmas Lecture at the Science Museum, London), 1535
Science and Magic (Christmas Lecture at the Science Museum, London), 1535
Calcareous Organisms (Fossil) Determination of the Temperatures of Ancient Seas by the Measurement of the Oxygen Isotopes Ratio in (Y A Birstein), 1025
Calcite Etching of (Dr N S Pandya and J R Pandya), 894
Calcium (Cellular) Heparin and (D Thomason and R Schofield), 1712
Calcium (Ionized), in Biological Media (Prof J Ettori and Sybil M Scoggan), 1315
Calcium and Magnesium (Potassium,) . Effect on the Groundnut of Variations in Supply of (Dr R Comber), 1003
Calcium Carbonate A Method for Determining Carbon-14 by Combustion using (E C S Little), 900
Calcium Ions and the Permeability of Human Red Cells (Prof M Maizels), 366
Calcium Phosphate Purification of Herpes Simplex Virus by Chromatography of (Janice Taverne and Peter Wildy), 1655
Calcium Sulphate Hemihydrate Transition of, to Insoluble Anhydrite (Chikara Mitsuki and Masayoshi Kita), 1481
Calcretes and Ferricretes Pleistocene Climatic Significance of (Dr R J Mason, A B A Brink and K Knight), 568
Calculating the Taft's Constants σ^* An Attempt at (Rudolf Zahradnik), 1865
Calculation of a 'Cosmic Ray Age' for the Iron Meteorite 'Carbo' (Dr Royal R Marshall), 117
Calculation of the Median Sky Wave Field Strength in Tropical Regions (W R Piggott), 605

Calder, E A Nitrogen Fixation in a Uganda Swamp Soil, 746
Calder, J A Origin and Dispersal of Flowering Plants (Post-Pleistocene Distributions in British Columbia), 1200
Calf Absorption of Magnesium in the Large Intestine of the (Dr R H Smith), 821
Calf Kidney Cells Interferon produced by Cultures of (Dr D A J Tyrrell), 452
Calf Thymus High Molecular Weight Ribonucleic Acids from the Nuclei of (Dr Ping-yao Cheng), 190
California and Alaska Micropulsation Measurements in (W H Campbell and B Nebel), 628
California Academy of Sciences Proceedings, Vol 29, No 15, Behavior and Reactions of the Pacific Sardine *Sardinops caerulea* (Girard) under the Influence of White and Colored Lights and Darkness (Dr A S Loukashkin and Dr N Grant), 865
California Institute of Technology Grant of 155,000 dollars from the United States National Science Foundation, 683
  Appointment of Dr Richard P Feynman to the Tolman chair of theoretical physics, 768
Callear, Dr A B, and Norrish, Prof R G W Mechanism of Anti-Knock, 1794
Callerio, Dr Carlo Appearance of Granules in the Cytoplasm of Tumour-Cell Cultures in Contact with Lysozyme, 202, *erratum*, 508
Calliactus parasitica (The Sea Anemone), and the Hermit Crab (*Eupugarus bernhardus*), (Dr D M Ross), 1161
Callick, E B (Thomson, Dr J, and) Electron Physics and Technology, *review* by Dr D A Bell, 83
Callija, J B Awarded a Spanish Fellowship in Chemistry for 1959-60 by the Ramsay Memorial Fellowships Trustees, B A 16
Calliphora erythrocephala Meig (Female) Hormonal Control of Selective Feeding in (J Strangways-Dixon), 2040
Calliphora vomitoria Electron Spin Resonance Investigations of *Allium cepa* and (M Edwards, Dr G A Kerkut, K A Munday, Dr D J Ingram, M C Saxena and K Leach), 1402
Callow, D S (Pirt, S J, and) Continuous-Flow Culture of the Filamentous Mould *Penicillium chrysogenum* and the Control of its Morphology, 307
Callow, Dr R K, and others Extraction and Purification of 'Queen Substance' from Queen Bees, 1871
Callow, W J Radiocarbon Dating, 673
Calmette-Guerin Infection (Bacillus) Effect of, on Transplanted Tumours in the Mouse (Dr Lloyd J Old, Dr Donald A Clarke and Dr Baruj Benacerraf), 291
Calorimetric Method Ultrasonic Absorption in Acetic Acid at 450 kc/s by the (S Parthasarathy and V N Bindal), 631
Calorimetry Conference Fourteenth Annual, 1194
Calverley, A Heating by Electron Bombardment, 690
  Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (An Improved Electron Bombardment Apparatus), 691, (Vanadium Diboride decomposes with Loss of Vanadium), 691, (Drop Weight Surface Tension Measurement of Liquid Tungsten), 692
Calvert, Dr N G Appointed to a senior lectureship in mechanical engineering in the University of Liverpool, 410
Cama, H R, and others Biochemical Research in India (Occurrence of Flavin Nucleotides in Plants and the Changes in their Concentration with Germination of Green Gram and Cow Pea), 1368
Camanni, F, and others Abolition by Chlorpromazine of the Inhibiting Effect of Iproniazid on the Depletion of Adrenal Catechol Amines induced by Reserpine, B A 65
Cambodia Blood-feeding Habits of Adult Noctuidae (Lepidoptera) in (W Buttiker), 1167
Cambridge Instrument Company, Ltd New Research Laboratories for the (Dr M C Marsh), 1364
Camellia japonica Pattern and Control of Sclereid Formation in the Leaf of (Donald E Foard), 1663
Cameron, A, and Stacey, W O Coal Science (Ultra-fine Structure of Coals and Chars—Two Distinct Pore Systems in Chars prepared from Brown-coals), 413
Cameron, John L, and others Chronic Schizophrenia, *review* by Prof Martin Roth, 487
Cameron, Kenneth The Place-Names of Derbyshire, Part 1, Introduction, River-Names, etc, High Peak Hundred, Part 2, Scarsdale Hundred, Wirksworth Hundred, Morleyston and Litchurch Hundred, Part 3, Appletree Hundred, Repton and Gresley Hundred, Analyses, Index, *review* by I S Maxwell, 1767
Campanula rapunculus L Carbohydrates of the Rampion (Dr J S D Bacon), 1957
Campbell, H G Installed as president for 1959-60 of the Illuminating Engineering Society, 1272
Campbell, Dr P N Appointed secretary to the Committee of the Biochemical Society, 1192
Campbell, W H, and Nebel, B Micropulsation Measurements in California and Alaska, 628
Camus, Albert Elected an Honorary Member of the American Academy of Arts and Sciences, 409
Canada Isolation of the Antifungal Substance, 6-Methoxybenzoxazolinone, from Field Corn (*Zea mays* L) in (N J Whitney and C G Mortimore), 1320
Canadian Committee on Space Research, 24
Canadian Department of Transport Retirement of Dr Andrew Thomson as director of the Meteorological Branch, 1105
  Appointment of Patrick D McTaggart-Cowan as director of the Meteorological Branch, 1105
Canadian Institute of Oceanography, 769
Canadian Patents and Development, Ltd Forty-second Annual Report of the National Research Council of Canada (1958-59), including the Annual Report of, 1916
Canadian Veterinary Medical Association Eleventh Annual Convention, 695
Cancer and the Respiratory Grana (Prof Carl C Lindegren), 397
Cancer Cells (Normal and) Localization of β-Glucuronidase in (J Conchie and Dr G A Levvy), 1709
Cancer Current Literature Index (Excerpta Medica Foundation), 941
Cancer Hospital, Royal Extension to the Chester Beatty Research Institute, B A 15
Cancer Research (Fundamental) Fourteenth Annual Symposium on (Cell Physiology of Neoplasia), (University of Texas Anderson Hospital and Tumour Institute), 1451
Cancer Research Fund (Imperial) Fifty-sixth Annual Report (1957-58), 783
Candy, A J, and others Semi-Albino, a Third Sex-linked Allelomorph of Silver and Gold in the Fowl, 480
Canine Distemper Virus in Tissue Culture An Attenuated Strain of (Prof Gunnar Rockborn), 822
Cantino, Prof Edward C, and Turian, Gilbert Gamma Particles, Nadi-Positive Mitochondria, and Development in the Water Fungi *Blastocladiella* and *Allomyces*, 1889
Capacitance Method for following Vinyl Polymerizations initiated by γ-Rays (G J K Acres and F L Dalton), 335
Capacity (Invasive) Relation of, to Passage of Lymphocytic Cells through Cellulose Membrane Filters (Dr Emma Shelton and Dr Mary E Rice), 479
Cape Town Science Exhibition, 1959 (Dr Ronald Singer), 952
Capillary Gas Chromatographic Columns (Packed and) Comparison of Efficiency and Separating Power of (Dr J H Purnell), 2009
Capillary Permeability (Increased) Pharmacological Suppression of, following Irradiation of the Intestine of Rats (Dr D A Willoughby), 1156
Capsicum Species of West Africa (C Oyolu), 1163
Captive Marine Birds possessing a Functional Lateral Nasal Gland (Salt Gland), (Prof Larry Z McFarland), 2030
α-Carbethoxy-L-lysyl-L-serylglycine and its O-Phosphorylated Analogue Action of Trypsin on (Dr D Theodoropoulos, H Bennich, G Folsch and Prof O Mellander), 187
Carbide in Low-Carbon Iron-Silicon Alloys X-Ray Diffraction Pattern of (G Konoval, L Zwell, L A Gorman and W C Leslie), 1862
Carbide (Silicon) Semiconducting (Dr H K Henisch), 158
Carbides (Grain Boundary), found in Austenitic Stainless Steel Chromium Distribution around (B E Hopkinson and K G Carroll), 1479
'Carbo' (Iron Meteorite) Calculation of a 'Cosmic Ray Age' for the (Dr. Royal R Marshall), 117
Carbo-Nitriding Identification of the High-Temperature Constituent in Mild Steel Surface-Hardened by (M A H Howes, G T F Jay, K Sachs and D Wilkinson), 1312
Carbohydrate—Amino-Acid Inter-relations in Brain Cortex *in vitro* (M M Kini and Prof J H Quastel), 252
Carbohydrate Chemistry Advances in (edited by Melville L Wolfrom in association with R Stuart Tipson), Vol 13, *review* by Dr Alfred Gottschalk, 662
Carbohydrate Metabolism in the Experimental Galactose Cataract (Dr Sidney Lerman), 1406
Carbohydrate Metabolism in Hypervitaminosis A (Amal Ray and Prof D P. Sadhu), 1323
Carbohydrate Sulphate Esters Infra-Red Spectra of (Dr A G Lloyd and K S Dodgson), 548
Carbohydrate-free Johnin Protein Preparation of a Highly Purified (E Annau), 1642
Carbohydrates The Moving Front of, *review* by Dr Alfred Gottschalk, 662
Carbohydrates of the Rampion, *Campanula rapunculus* L (Dr J S D Bacon), 1957
Carbohydrates (Complex) Medical Aspects of (Prof M Stacey), B A 42
Carbohydrates (Simple) Action of Manganese Dioxide on (Dr J L Bose, Dr A B Foster, Prof M Stacey and Dr J M Webber), 1301
Carbon Substitution at Elements other than (Sir Christopher Ingold), *review* by Dr R I Reed, 1262
Carbon-14 Conversion of Salicylic Acid to Gentisic Acid and o-Pyrocatechuic Acid, all Labelled with, in Plants (Dr Ragai K Ibrahim and Prof G H N Towers), 1803
  A Method for Determining, by Combustion using Calcium Carbonate (E C S Little), 900
  Preliminary Observations on the Fate of Intravenously Administered Lactose Labelled with (Dr Frederick J Carleton and Dr Henry R Roberts), 1650
Carbon-dating Conference at Groningen, September 1959 (Dr H Godwin), 1365
Carbon-14 Incorporation Pathway of, from $NaH^{14}CO_3$ to Haem in Duck Blood incubated *in vitro* (A Breccia, A L Fantola, E Lazzarini and A Giustina), 1879
Carbon-14-labelled Amino-Acids and Amides in the Stems of young Soya Bean Plants Translocation of (C D Nelson and P R Gorham), 855
Carbon-14 Dioxide Experiments with Hydrocortisone Liver Glucosyl Oligosaccharides and Glycogen— (Dr Hsien-Gieh Sie, Prof James Ashmore, Dr Robert Mahler and Prof William H Fishman), 1380
Carbon-Carbon Single Bonds Effect of Hybridization Changes on the Bond Energies of (J E Bloor and S Gartside), 1313
Carbon (Low-) Iron-Silicon Alloys X-Ray Diffraction Pattern of Carbide in (G Konoval, L Zwell, L A Gorman and W C Leslie), 1862
Carbon (N-Methyl), of Monoethylaminoazobenzene Incorporation of, into Polar Dyes (Prof Hiroshi Terayama, Prof Morizo Ishidate and Akira Hanaki), 1460
C_{17}-OH Group of Œstradiol—Relationships between its Anti-Atherogenic and Endocrine Actions (Dr Manuel Rene Malinow, Alvaro L Gimeno, Amanda A Pellegrino-Iraldi, Martha A Fernandez-Gimeno, Jorge L Lacuara and Jaime A Moguilevsky), 1720
Carbon Compounds Chemistry of (edited by Dr E H Rodd), Vol 4, Part B, Heterocyclic Compounds, *review* by Dr F G Mann, 1758
Carbon Dioxide Vibrational Relaxation and Dissociation of, behind Shock Waves (Dr I R Hurle and Dr A G Gaydon), 1858
Carbon Dioxide in Water, in Wine, in Beer and in other Beverages (F Justin Miller) *review* by Dr A H Cook, 302
Carbon Dioxide Output of Individual Insects The Infra-Red Gas Analyser as a Means of Measuring the (Dr A G Hamilton), 367
Carbon Dioxide and Air (Hydrogen,) Habit of Ice Crystals grown in, at Reduced Pressure (A P van den Heuvel and Dr B J Mason), 519
Carbon Fatty Acids (Odd-Numbered), from Propionate Production of, by Mice (Prof S B Tove), 1647
Carbon Gasification A New Approach to (J D Blackwood and F K McTaggart), 447
Carbon-Oxygen Bonds in some Aromatic Compounds Hydrogenolysis of, by Electrolysis (Dr P H Given and Dr M E Peover), 1064

Carbon Tetrachloride Effects of, on the Kidney and Liver Function in the Sheep (Dr B P Setchell), 1242
  Prophylaxis of Poisoning by (C H Gallagher and R A Simmonds), 1407
Carbonate (Calcium) A Method for Determining Carbon-14 by Combustion using (E C S Little), 900
Carbonate Minerals in Hydrated Portland Cement (W F Cole and B Kroone), B A 57
Carbonic Anhydrase in the Deciduoma of the Rat (Dr T H Johnson, Dr C Lutwak-Mann and Prof M C Shelesnyak), 961
Carbonic Anhydrase in Erythrocytes Influence of X-Rays on the Activity of, and on their Haemolytic Resistance (A Lauwers, J Van Bavinchove and W Dierick), 111
Carbonization of Coals in the Presence of Activated Charcoal (Studies of Coal), (R L Bond, A M Godridge, A R Murnaghan, D H Napier and D J Williams), 425
Carbonization at Different Heating Rates Number of Free Radicals in Coal during (J Smidt and Prof D W van Krevelen), 719
Carbons Effects of Heating on X-Ray Diffraction by (Eitaro Matuyama), 544
Carbonyl Compound (A New), from *Piper methysticum* Forst (Prof Paul J Scheuer and Thomas J Horigan), 979
Carbonyl Compounds (Aliphatic) A Correlation between the Shift in the Ultra-Violet Absorption Maxima and the Electronegativity of the Adjacent Atoms in some (Dr P Borrell), 1932
5-Carboxymethylhydantoinase Distribution of (Dr Lloyd H Smith, jun , Faith A Baker, Margaret Sullivan and Lawrence J Kunz), 1314
Carcasses and Bodies (Fat-free), of New Zealand Sheep Composition of some (A H Kirton, M J Ulyatt and R A Barton), 1724
Carcharodon megalodon’ Age of (W Tschernezky), 1331
Carcinogen Urethane as an, and as an Anaesthetic for Fishes (Dr J N Ball and Prof P N Cowen), 370
Carcinogenicity and Ease of Hydrolysis *in vitro* of Derivatives of 2-Aminofluorene Possible Relation between (Prof Mary F Argus and Francis E Ray), 2018
Carcinoma (Ehrlich Ascites) Effect of Chlorpromazine on Crocker Sarcoma and (Prof M Chorazy), 200
Carcinomas (Human) Aneuploid Deoxyribonucleic Acid Content of (H F Stich and H E Emson), 290
Carcinostatic Agent Phenazine Di-*N*-Oxide as a (Arthur Furst, Claire Klausner and Windsor C Cutting), 908
Cardew, M H , and Eley, Prof D D Energy Transfer with special reference to Biological Systems (Measurements on the Semiconductivity of Amino-acids, Haemoglobin and Globin), 689
Cardiac Aglycone Microbiological Transformation of a (Hayao Nawa, Masao Uchibayashi, Takaaki Kamiya, Togo Yamano, Hideo Arai and Matazo Abe), 469
Cardiac Output in Horses (E W Fisher and R G Dalton), 2020
Cardiolipin-like Compound in Rat Liver Mitochondria (G S Getz and W Bartley), 1229
Care, A D , and others Excretion of Labelled Magnesium by the Sheep, 736
Care of Churches, Central Council for the, and the Society for the Protection of Ancient Buildings Report on the Conservation of English Wallpaintings, 119
Career Pharmacy as a (Central Youth Employment Executive), 95
Career in Education for University Graduates (Ministry of Education), revised edition, 1777
Caribbean (British), Regional Research Centre of the Soil and Land-Use Surveys, No 1, Parish of St Catherine, Jamaica (K C Vernon) , No 2, The Rupununi Savannas of British Guiana (R F Loxton, G K Rutherford and J Spector) , No 3, St Vincent (J P Watson, J Spector and T A Jones), 27
Caris, J (Blom, L , and) Quantitative Paper Chromatography based on the Sub-Micro Titration of Derivatives containing Nitro Groups, 1313
Carleton, Dr Frederick J , and Roberts, Dr Henry R Preliminary Observations on the Fate of Intravenously Administered Lactose Labelled with Carbon-14, 1650
Carlisle, A (Steven, Prof H M , and) The Native Pinewoods of Scotland, *review* by Prof E W Jones, 133
Carlisle, Dr D B *Obituary* of Dr Gustav J Kramer, 22
Carlisle, Dr D B , and Knowles, Sir Francis Endocrine Control in Crustaceans, *review* by Prof J H Welsh, 1761
Carlsberg Foundation's Oceanographical Expedition round the World 1928-30, and previous *Dana* Expeditions *Dana* Report No 46, The Hydromedusae of the Atlantic Ocean and adjacent Waters (P L Kramp), *review* by J H Fraser, 300
Carlsberg–Wellcome Travelling Research Fellowships awarded to Michael Weis Bentzon and to John Anthony Hunt, 683
Carmichael, Dr Leonard History of Technology, *review*, B A 5
Carnegie, P R , and Synge, Dr R L M Structure and Chemistry of Proteins (Electrophoretic Behaviour of Cupric Complexes of Oligopeptides), 1277
Carnegie Trust for the Universities of Scotland Fifty-seventh Annual Report (1957-58), 97
Carnivores British (R F S Creed), 1535
Carotenes in Carrot Extracts Biosynthesis of (Dr V V Modi and D K Patwa), 983
Carotenoid Pigments Function of, in Non-Photosynthetic Bacteria (Micheline M Mathews and W R Sistrom), 1892
  Light-induced Production of, by *Cephalosporia* (R C Codner and B C Platt), 741, *erratum*, 1108
Carotenoids Destruction of, in Isolated Chloroplasts (J Friend and T O M Nakayama), B A 66
  Function of, in Photosynthetic Bacteria (Prof M Dworkin), 1891
  Influence of, on the Infra-Red Spectrum of Bacteriochlorophyll in *Chromatium* (Dr J A Bergeron and Dr R C Fuller), 1340
  Photochemical and Stereochemical Properties of, at Low Temperatures (Staff of the Biological Laboratories of Harvard University)—Photochemical Behaviour of Retinene (Dr Lawrence Jurkowitz), 614 , *Cis-trans* Isomerism and Steric Hindrance (John N Loeb, Paul K Brown and Prof George Wald), 617 , Discussion (Prof George Wald), 620
Carp *Glaucoma* Species in the Central Nervous System of the (Prof A Stolk), 1737
Carr, Dr D J , and Carr, S G M Floral Morphology and the Taxonomy of Eucalyptus, 1549
Carr, Dr J G (Whiting, Dr G C , and) Metabolism of Cinnamic Acid and Hydroxy-Cinnamic Acids by *Lactobacillus pastorianus* var *quinicus*, 1427
Carr, S G M (Carr, Dr D J , and) Floral Morphology and the Taxonomy of Eucalyptus, 1549
Carrier (Sodium) Evidence for Phosphatidic Acid as the (Dr Lowell E Hokin and Mabel R Hokin), 1068
Carrier Gas and Sensitivity in Gas Chromatography (E M Fredericks, M Dimbat and F H Stross), B A 54 , (Dr N H Ray), B A 54
Carrion-Eating by Ophiuroids (A K Nagabhushanam and J S Colman), 285
Carroll, Sir John An Absolute Scale of Time, 260
Carroll, K G (Hopkinson, B E , and) Chromium Distribution around Grain Boundary Carbides found in Austenitic Stainless Steel, 1479
Carroll, Dr P K , and Rubalcava, Dr H E Near Infra-Red System of Nitrogen, 119
Carrot Extracts Biosynthesis of Carotenes in (Dr V V Modi and D K Patwa), 983
Carruthers, D D Gelation (Measurements on Gelatine Gels at High Frequency), 863
Carruthers, Dr J N The New Marine Biological Station on Heligoland, 400
  Polar Front Survey—Hydrography (Greenland and Norwegian Seas), 1181 , (Shetland–Faroe–Iceland Region), 1182
Carruthers, Dr W , and Johnstone, Dr R A W Composition of a Paraffin Wax Fraction from Tobacco Leaf and Tobacco Smoke, 1131
Carson, Dr Paul E , and others Glucose-6-Phosphate Dehydrogenase and Human Erythrocytes—Mechanism of Inactivation of Glucose-6-phosphate Dehydrogenase in Human Erythrocytes, 1292
Carter, Prof C F Appointed a member of the Council for Scientific and Industrial Research, 1362
Carter, Prof C F , and Williams, Prof B R Investment in Innovation, *review* by Prof A J Brown, 1348
  Science in Industry—Policy for Progress, 1827
Cartilage Homografts in Papain-injected Rabbits (M B L Craigmyle), 1243
Cartwright, D G (Ellis, G R A , and) Directional Observations of Radio Noise from the Outer Atmosphere, 1307
Cartwright, D G , and others Spaced Observations of Radio Noise from the Outer Atmosphere, 1391
Carvers in Argillite Haida (Prof Marius Barbeau), 409
Casanova, J , and others Two Cases of Triple Fission of Uranium-235, 1057
α-Casein The N-Terminal Amino-Acids of (Dr W Manson), 1393
Cason, James (edited by) Organic Syntheses, Vol 37 (1957), *review* by Prof John Read, 134
Casselman, Dr W G Bruce Histochemical Technique, *review* by Dr T Kerr, 752
Cassman, M , and others Two Enzymic Mechanisms for Hydrogen Transport by Phenolic Œstrogens, 427
Cast Iron Research Association, British—Open Days (H Morrogh), 323
Castermans, Andre, and Oth, André Transplantation Immunity—Separation of Antigenic Components from Isolated Nuclei, 1224
Castillejo Dr L Nuclear Forces and the Few-Nucleon Problem (Scattering of Nucleons by Light Nuclei at High Energy), 1113
Castration Effect of Sexual Maturation and, on the Sex Chromatin Pattern in the Male Rat (St Zsifkovits, Ch Mehes and C Jobst), 1239
Castro, A , and others Histological Localization of Fluorescent Thyroid-stimulating Hormone in Rat Tissues, 1733
Caswell, G H (Williams, C N , and) An Insect attacking *Striga*, 1668
Cat Induced Tolerance to D-Tubocurarine Chloride in the (Fiona Acheson and Dr R J M Fry), 1409
Cat (Unanaesthetized) Evoked Potentials in Visual Cortex of the (Gabriel Horn and John Blundell), 173
Catala, J , and others Two Cases of Triple Fission of Uranium-235, 1057
Catalases of Acid-fast Bacilli Difference between the (Wieslaw Tysarowski and Stanislaw Kwiek), 1513
Catalysis, *review* by Dr E B Maxted, 750
Catalysis (edited by Prof Paul H Emmett), Vol 5, Hydrogenation, Oxo-Synthesis, Hydrocracking, Hydrodesulphurization, Hydrogen Isotope Exchange and related Catalytic Reactions, *review* by Dr E B Maxted 750 , Vol 6, Alkylation, Isomerization, Polymerization, Cracking and Hydroreforming), *review* by Dr David M Wilson, 1090
Catalysis Contact (Dr R H Griffith and J D F Marsh), *review* by Dr E B Maxted, 1262
  Heterogeneous, *review* by Dr F S Stone, 1974
Catalysis and related Subjects Advances in, Vol 9, (edited by Adalbert Farkas), *review* by Dr E B Maxted, 750 , Vol 10, (edited by D D Eley, W G Frankenburg and V I Komarewsky), *review* by Dr F S Stone, 1974
Catalyst (Copper-) Blocking Agent Inhibition of Rous 1 Sarcoma Metastases by a (Dr B M Jones), 1963
Catalytic Processes and Petroleum, *review* by Dr David M Wilson, 1090
Cataract (Experimental Galactose) Carbohydrate Metabolism in the (Dr Sidney Lerman), 1406
Cataract (Radiation) Possible Mechanism of Cysteine Protection against (A Pirie and L G Lajtha), 1125
Cataract ('Sugar') Formation of Polyols by the Lens of the Rat with (Dr Ruth van Heyningen), 194
Catcheside, Prof D G Cytoplasmic Inheritance 1012
Catchment Areas (Tropical) A Physical Basis for Land Use Policy in (Dr H C Pereira), 1768
Catechol Amines Effects of 1,4-Dihydrazinophthalazine on Organ Content and Adrenal Medullary Secretion of (M Bygdeman and L Stjarne), 1646
Catechol Amines (Adrenal), induced by Reserpine Abolition by Chlorpromazine of the Inhibiting Effect of Iproniazid on the Depletion of (F Camanni, Dr G M Molinatti and M Olivetti), B A 65
Catharometers in Gas Chromatography Sensitivity of, and the Thermal Conductivity of Binary Gas Mixtures (A B Littlewood), 1631
Cathode (Oxide) Current Fluctuations in the (Margaret Chisholm and Dr L Jacob), 1058
Cathode Surfaces Insulating Particles on—their Effect upon Electrical Discharges (L B Griffiths and P C L Pfeil), 1475
Cationic Detergent Interaction between Nucleic Acid and a (Prof Dino Guerritore and Luciano Bellelli), 1638
Cationic Macromolecules Reduction of Toxicity of, by Complexing with Anionic Derivatives of Synthetic Polyglucoses (P T Mora, B G Young and M J Shear), 431

Cations (Exchangeable), in Vermiculite Diffusion of (G F Walker), 1392
Cations (Monovalent), and the Incorporation of Metabolites by Isolated Thymus Nuclei (Dr Theodore R Breitman and Dr George C Webster), 637
Cats (Laboratory) Reduction in the Anoestrus Period of, by Increased Illumination (Dr Patricia P Scott and Marny A Lloyd-Jacob), 2022
Catterall, Dr J A A Handbook of Lattice Spacings and Structures of Metals and Alloys, *review*, 841
Cattle Infection of, with *Cysticercus bovis* by the Injection of Onchospheres (G Froyd and M C Round), 1510
Cattle and Buffaloes of India, 941
Cattle (Beef), (*Bos taurus* and *Bos indicus*) A Possible Explanation for Part of the Difference in Heat Tolerance Exhibited by (H P Ledger), 1405
Cattle (Grazing) A Relationship between Weight of Internal Fat, 'Fill', and the Herbage Intake of (J C Tayler), 2021
Cattle (Zebu) β-Globulin Alleles in some (G C Ashton), 1135
Cauer, Wilhelm Synthesis of Linear Communication Networks, second edition edited by Wilhelm Klein and Franz M Pelz (translated from the German by G E Knausenberger) *review*, 1525
Cause of Reverse Thermo-Remanent Magnetism Exchange Interaction as a (T Nagata and S Uyeda), 890
Cause of Wear in Sheeps' Teeth (Dr G Baker, Dr L H P Jones and I D Wardrop), 1583
Causes de la Répartition des Êtres Vivants (Raymond Furon), *review* by Prof Ronald Good, 390
Cavallini, D, and others Degradation of Thiotaurine by Ionizing Radiations, B A 61
Cave-Browne-Cave, Wing-Comdr T R At the Annual General Meeting and Conference of the Mathematical Association (Mechanics of the Fun Fair), 33
Cawley, Dr C M Appointed chief scientist to the Ministry of Power, 232, work of, 232
Cayless, M A Ionization Phenomena in Gases (The Positive Column of Low-pressure Mercury-rare Gas Discharges), 1355
Cedarholm, J P, and Townes, Prof C H A New Experimental Test of Special Relativity, 1350
Cell and Organ Culture (British Association for the Advancement of Science, Section I (Physiology and Biochemistry), Discussion on), 935
Cell and Tissue Culture (Dr John Paul), *review* by Dr I Leslie, 1009
Cell (Bacterial) Affinity of Lysozyme to Structural Elements of the, as studied with Enzyme Labelled with Radioactive Iodine (Prof C Weibull, B Zacharias and H Beckman), 1744
Cell (Living) Inside the (Dr J A V Butler), *review* by Dr W L Sumner, 134
Cell (Red Blood) Receptors Influence of Streptomycin Solutions on the Interaction between the Agglutinating Sera and the Corresponding (Dr M Kout and Dr Z Kubickova), 639
Cell (Retinula) Response of a Single, to Polarized Light (M Kuwabara and K Naka), 455
Cell (Tumour-) Cultures in Contact with Lysozyme Appearance of Granules in the Cytoplasm of (Dr Carlo Callerio), 202, *erratum*, 508
Cell (Unit), of Mercuripapain Crystals (J Drenth and J N Jansonius), 1718
Cell Culture Growth-Controlling Action of Human Serum in (Dr Kari Penttinen and Dr Erkki Saxen), 1570
Cell Cultures (Monkey Kidney), infected with Poliomyelitis Virus and Incubated at 22°-30°C Appearance of Crystalline Needles in (Dr Esther Tenenbaum), 1657
Cell Fragments Paper Chromatography of (A T Wilson), 2016
Cell Lines (Unsusceptible) Infectivity of Polio Virus Ribonucleic Acid for Embryonated Eggs and (P De Somer, Dr A Prinzie and E Schonne), 652
Cell Membranes in the Anterior Pituitary Gland A Dense Laminar Structure found in Conjunction with (Barbara G Barnes), 651
Cell Membranes (Plant) Maintenance of Semipermeability of, in the Absence of Metabolic Energy Supply (Dr B Ginzburg), 1073
Cell Physiology of Neoplasia (University of Texas Anderson Hospital and Tumour Institute fourteenth Annual Symposium on Fundamental Cancer Research), 1451
Cell Population (Mast), of Lung of the Guinea Pig and other Tissues (Dr W G Smith), 1154
Cell Types (New), in the Salivary Glands of the Brown Ear Tick, *Rhipicephalus appendiculatus* Neumann (Dr W M Till), 1078
Cell–Virus Relationships (Different) Formation of, in Tumour Cells induced by Polyoma (Dr Leo Sachs and Ernest Winocour), 1702
Cell-Wall Formation in Root Hairs (A B Wardrop), 996
Cell-Wall Mucopeptides of *Staphylococcus aureus* and *Micrococcus lysodeikticus* (H J Rogers and H R Perkins), 520
Cell Walls (Maize Coleoptile) A Partial Chemical Characterization of, prepared with the Aid of a Continually Renewable Filter (Prof Aleksander Kivilaan, Teofila C Beaman and Robert S Bandurski), B A 81
Cell-free Enzymes Combined Use of Polymyxin and Acetone to obtain (J R Villanueva), 1565
Cell-free Extracts Effect of, from *Mycobacterium tuberculosis* $H_{37}Rv$ on Lung Succinooxidase (Dr A Bekierkunst and M Artman), 458
Cellobiose Structure of (Robert A Jacobson, Jeffrey A Wunderlich and Prof William N Lipscomb), 1719
Cells The Culture of, *review* by Dr I Leslie, 1009
Cells of Higher Plants A New Technique for Isolating and Cloning (Ludwig Bergmann), 648
Cells with Modified Deoxyribonucleic Acid Unimpaired Mitosis in (Rolla B Hill, jun, Klaus G Bensch and Donald W King), 1429
Cells of Pea and Wheat Embryos Fine Structure in (G Setterfield, H Stern and F B Johnston), 505
Cells which Synthesize Deoxyribonucleic Acid in Guinea Pig Bone Marrow during Recovery from Whole-Body γ-Irradiation (P F Harris and J H Kugler), 1883
Cells (Algal) Value of a Simple Observational Technique for Determining the Fat Content of (Dr J H Evans), 1737
Cells (Bacterial), utilizing Hydrocarbons for Growth Incorporation of Molecular Oxygen in (E R Leadbetter and J W Foster), 1428
Cells (Blood), of *Drosophila melanogaster* *In vitro* Cultivation of, in a Synthetic Medium (Dr Masakatsu Horikawa and Dr Yukiaki Kuroda), 2017
Cells (Calf Kidney) Interferon produced by Cultures of (Dr D A J Tyrrell), 452
Cells (Circulating Blood) Synthesis of Haem by (Peggy Clark and Dr R J Walsh), 1730
Cells (Damaged Endothelial) Some Properties of (Dr J R O'Brien), 1580
Cells (Duck Red), *in vitro* Rôle of Stroma in Haemoglobin Synthesis—Experiments on (A Breccia A L Fantola, E Lazzarini and A Giustina), 1878
Cells (Frog Nerve) Resting and Action Potentials of Reversed Polarity in (Dr I Tasaki), 1574
Cells (Frozen Fat Body), in an Insect Survival of (R W Salt), 1426
Cells (Glial), (Isolated, Fresh Nerve Cells and) from Control and Stimulated Animals Quantitative Assay of Compounds in (Prof Holger Hyden), 433
Cells (HeLa) Discarded Blood Bank Blood as a Source of Protein for Cultivation of (Billy R Blakey and Prof George E Gifford), 1158
Cells (Human Erythroid), *in vitro* Lack of Direct Effect of Erythropoietin on (Edward L Alpen, L G Lajtha and Donald C Van Dyke), 1228
Cells (Human Red) Accumulation of Dextran in, after Haemolysis (N V B Marsden and S G Östling), 723
  Calcium Ions and the Permeability of (Prof M Maizels), 366
Cells (Human Tissue Culture) Cellular Uptake of Deoxyribonucleic Acid by (Dr Stanley M Gartler), 1505
Cells (Intact Ascites Tumour) Efficiency of the Mitochondrial Oxidative Phosphorylations in (Dr P Emmelot and C J Bos), 2024
Cells (Isolated, Fresh Nerve) and Glial Cells from Control and Stimulated Animals Quantitative Assay of Compounds in (Prof Holger Hyden), 433
Cells (Liver and Kidney) Absorbancy Measurements on (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Dr Bo Thorell and Prof Britton Chance), 934
Cells (Lymphocytic), through Cellulose Membrane Filters Relation of Invasive Capacity to Passage of (Dr Emma Shelton and Dr Mary E Rice), 479
Cells (Mammalian), in Culture X-Ray Damage and Recovery in (M M Elkind and Harriet Sutton), 1293
Cells (Mouse Ascites Tumour) Growth Inhibition of, by Powdered Tragacanth (Tragacanthae Pulvis, B P), (Dr E M F Roe), 1891
Cells (Multiplying HeLa) Deoxyribonucleic Acid Formation in (C L Smith, A A Newton and P Wildy), 107
Cells (Muscle), of *Ascaris lumbricoides* Electrical Activity in the (Dr M Jarman), 1244
Cells (Nerve), in the Ferret Pituitary Gland A Nucleus of (Dr R L Holmes), 1819
Cells (Normal and Cancer) Localization of β-Glucuronidase in (J Conchie and Dr G A Levvy), 1709
Cells (Parenchymatous Liver) Some Enzymatic Properties of Suspensions of (Dr Keith S Henley Ole Sorensen and H Marvin Pollard), 1400
Cells (Polyethylene Absorption), for Infra-Red Spectrophotometry (Trevor Robinson), 448
Cells (Proliferating Donor), in Chick Embryos injected with Adult Chicken Blood Cytological Identification of (P M Biggs and L N Payne), 1594
Cells (Purkinje Nerve), of some Mammals Sex Chromatin ('Chromoleme') in the (Nylceo Marques de Castro and Wilson da Silva Sasso), 293
Cells (Rat Mast) Release of Histamine from, by Blood treated with Dextran (Dr G T Archer), 1151
Cells (Red Blood) Coating of with Antigenic Substances (Dr K Deutsch), 278
Cells (Shielded), (Glove Boxes and), for Handling Radioactive Materials—a Record of the Proceedings of the Symposium on Glove Box Design and Operation held in the Cockcroft Hall, A E R E, Harwell, 1957 (edited by G N Walton), *review*, 1599
Cells (Single Living) Localization and Assay of Respiratory Enzymes in—Absorbancy Measurements on the *Nebenkern* (Dr Robert P Perry, Dr Bo Thorell, Dr Lennart Akerman and Prof Britton Chance), 929, Fluorescence Measurements of Mitochondrial Pyridine Nucleotide in Aerobiosis and Anaerobiosis (Prof Britton Chance and Dr Bo Thorell), 931, Absorbancy Measurements on Liver and Kidney Cells (Dr Bo Thorell and Prof Britton Chance), 934
Cells (Tobacco Leaf), capable of supporting Virus Multiplication Isolation of (Prof Milton Zaitlin), 1002
Cells (Tumour), induced by Polyoma Formation of Different Cell-Virus Relationships in (Dr Leo Sachs and Ernest Winocour), 1702
Cells (White Blood), of Rats (*WR* Strain) A Sex Difference in (Dr Hans Meier), 1082
Cells (Yeast) Release of Nucleotides from (Masataka Higuchi and Prof Teijiro Uemura), 1381
Cellular Blood Elements (Injured), in Extracorporeal Circuits Release of Adenosine Triphosphate and Serotonin from (Dr H S S Sarajas, Dr R Kristoffersson and Dr M H Frick), 1127
Cellular Calcium Heparin and (D Thomason and R Schofield), 1712
Cellular Hyperplasia Viral Multiplication and (Prof Councilman Morgan), 435
Cellular Slime Molds (Prof John Tyler Bonner), *review* by D Park, 1976
Cellular Uptake of Deoxyribonucleic Acid by Human Tissue Culture Cells (Dr Stanley M Gartler), 1505
Cellulose Anion Exchangers based on (Dr A O Jakubovic), 1065
  Evidence for a Hydrate of from Studies of its Surface Properties (Dr J M Joubert, Dr G J R Krige and Dr K Borgin), 1561
Cellulose Acetate Cross-linking of, by Ionizing Radiation (Dr S H Pinner, T T Greenwood and D G Lloyd), 1303
Cellulose Film (Transparent) Use of, for Roller Tube Tissue Cultures (John A Sharp) 1508
Cellulose Membrane Filters Relation of Invasive Capacity to Passage of Lymphocytic Cells through (Dr Emma Shelton and Dr Mary E Rice), 479
Cellulosic Fibres A Special Case of the Superposition of Crystal Plates between Crossed Polars and its Bearing on the Microscopy of (Dr N H Hartshorne), 179
Cement (Hydrated Portland) Carbonate Minerals in (W F Cole and B Kroone), B A 57
Cenozoic Volcanic Rocks in New Zealand Palaeomagnetic Studies of (Dr D S Coombs and Dr T Hatherton), 883
Census 1951, England and Wales Fertility Report, 1035
Centenary of the Petroleum Industry, 1611

Central Advisory Water Committee First Report of the Subcommittee on the Growing Demand for Water, B A 18
  Report of the Subcommittee on Information on Water Resources, B A 18
  Re-appointments and new appointments, 153
Central African Scientific Research 407
Central Agricultural Research Station, Carapichaima, Trinidad (Dr A J Vlitos), 331
Central Congo Basin Nitrogen Content of Rain Water collected in the Humid (J Meyer and E Pampfer), 717
Central Control of Interactions between Behaviour Patterns in a Hemileucine Moth (Dr A D Blest), 1164
Central Electricity Generating Board Grant of £3,860 to the University of Leeds, for research on the utilization of pulverized fuel ash, 1534
Central Nervous System Biochemistry and the (Prof Henry McIlwain), second edition, *review* by Dr G B Ansell, 1261
Central Nervous System of the Carp *Glaucoma* Species in the (Prof A Stolk), 1737
Central Youth Employment Executive Pharmacy as a Career, 95
Centre (The Iron-Binding), of Ferrichrome Compounds (Dr T Emery and Dr J B Neilands), 1632
Centre Interuniversitaire de Recherches enzymologiques Colloquium on Specificity in Protein Biogenesis, 1198
Centre National de la Recherche Scientifique Colloques Internationaux, No 84, Acoustique Musicale (Marseilles, 1959), *review* by Prof E G Richardson, 1902
Centrifuge Super-speed Servall *SS*-3 Automatic (Ivan Sorvall, Inc), 322
  SS-4 Enclosed (Ivan Sorvall, Inc), 322
Cephalopoda (Fossil) Conchiolin Remnants in Mother-of-Pearl from (Dr Ch Gregoire), 1157
Cephalosporia Light-induced Production of Carotenoid Pigments by (R C Codner and B C Platt), 741, *erratum*, 1108
Ceramic Research Association (British) New Mellor Library opened by Frank West, 153
  Symposium on Special Ceramics, 1115
  Retirement of Dr A T Green from the directorship, 1843
  Appointment of Dr N F Astbury as director, 1843
Ceramics Special (British Ceramic Research Association Symposium on), 1115
Cerebrospinal Fluid (Human) Glycoproteins of (Dr Samuel Bogoch), 1628
Cerebrospinal and Ocular Fluids and Tissues of the Foetal and Adult Sheep Inositol Concentration in the (D A Nixon), 906
Cerebrospinal Fluid and Urine α-Ketoglutaric Acid and Pyruvic Acid in Blood, (Dr E Zelnicek), 727
Cerenkov Radiation and its Applications (Dr J V Jelley), *review*, 1260
Cerium-142 α-Radioactivity of (F E Senftle, T W Stern and V P Alekna), 630
Cerletti, Dr A (Taeschler, Dr M , and) Differential Analysis of the Effects of Phenothiazine-Tranquillizers on Emotional and Motor Behaviour in Experimental Animals, 823
CERN see under European Organization for Nuclear Research
Chabod, Federico Elected an Honorary Member of the American Academy of Arts and Sciences, 410
Chabot, D L (Beaudry, J R , and) Chromosome Numbers in *Solidago*, 236
Chadwick, P Appointed lecturer in applied mathematics at the University of Sheffield, 684
Chadwick, Dr W B Prediction of Sunspot Numbers for Cycle 20, 1787
Chagas as Protozoologist, 1115
Chagas's Disease International Congress on (Dr J D Fulton), 1114
Chaiet, Alan H , and Chaiet, Louis Estimation of Vitamin C by Agar Diffusion, 1487
Chaiet, Louis (Chaiet, Alan H , and) Estimation of Vitamin C by Agar Diffusion, 1487
Chain (Respiratory), in Liver Mitochondria Functional Organization of the (Dr Tokuji Kimura and Dr Thomas P Singer), 791
Chain Fracture and Cross-Linking of Rubber by High-Energy Radiation Estimation of (P Hayden), 1865
Chain Reactors (Neutron) The Physical Theory of (Alvin M Weinberg and Eugene P Wigner), *review* by Dr J Walker, 1973
α-Chains Haemoglobin 'Bart's', a Foetal Haemoglobin without (Abnormal Human Haemoglobins), (Dr J A Hunt and Dr H Lehmann), 872
Chakraborty, S P , and Sen Gupta, S P Fixation of Nitrogen by the Rice Plant, 2033
Chakravorty, Animesh, and Basu, Dr Sadhan Visible Absorption Spectra of Copper-ethylene-diamine-*bis* (acetylacetone) in the Crystalline State, 50
Chakravorty, M , and Burma, D P Biochemical Research in India (Microbial Synthesis of Protein in relation to the Biogenesis of Nucleic Acids), 1367
Challenge of Science Education (edited by Joseph S Roucek), *review* by Dr W L Sumner, 923
Challenger, Prof Frederick *Obituary* of Prof H J Backer 1187
Challenger Society Joint Meeting with representatives from the marine laboratories (Development Commissioners' scheme), 410
Chaloner, W G Origin and Dispersal of Flowering Plants (Carboniferous Plants with Spores could be poorly represented as Macro-fossils), 1200
Chaloupka, J , and others Influence of DL-beta-Phenylserine on the Synthesis of Proteins in *Escherichia coli*, 1895
Chamberlain, Dr Owen (Segre, Dr Emilio, and) Awarded the Nobel Prize for Physics for 1959, 1189 , work of, 1189
Chambon, Pierre (Mandel, Prof Paul, and) Biological Effects of Low Doses of Ionizing Radiations (Ribonucleic Acid Synthesis in Rat Spleen after Whole-body Irradiation), 1112
  A New Approach to the Mechanism of Mutations, 1501
Champion, Dr F C Title of professor of experimental physics in the University of London (at King's College) conferred on, 1613
Champion, Sir Harry Forestry in New Zealand, 606
Chance, Prof Britton, and Jobsis, Frans Changes in Fluorescence in a Frog Sartorius Muscle following a Twitch, 195
Chance, Prof Britton, and Spencer, E L Energy Transfer with special reference to Biological Systems (Rapid Establishment of Redox Equilibria in the Cytochromes of Cells and Cell Particles at the Temperature of Liquid Nitrogen), 690
Chance, Prof Britton and Thorell, Dr Bo Localization and Assay of Respiratory Enzymes in Single Living Cells—Fluorescence Measurements of Mitochondrial Pyridine Nucleotide in Aerobiosis and Anaerobiosis, 931
Chance, Prof Britton and Yonatani, T Energy Transfer with special reference to Biological Systems (Fast Simultaneous Recordings of Cytochrome Oxidation and Disphosphopyridine Nucleotide Reduction), 690
Chance, Prof Britton, and others Localization and Assay of Respiratory Enzymes in Single Living Cells—Absorbancy Measurements on the *Neberkern*, 929
Chance, Prof Britton (Thorell, Dr Bo, and) Localization and Assay of Respiratory Enzymes in Single Living Cells—Absorbancy Measurements on Liver and Kidney Cells, 934
Chance Memorial Lecture of the Society of Chemical Industry (Dr W M Hampton), 772
Chance and Probability (British Association for the Advancement of Science, Section J (Psychology), Discussion on), 497
Chandrasekhar, Dr N Multiple Haemoglobins in Fish, 1652
Chang, Prof C C (Sedlund, F R , and) Blunt-Nosed Bodies in a High-Temperature Gas Jet, 812
Chang, Dr M C Fertilization of Rabbit Ova *in vitro*, 466
Chang, Y E (Westheimer, Prof F H , and) Oxidation of Organic Compounds (Oxidation of Pinacol and its Monomethyl Ether), 326
Change of Absorption Spectrum of Flavin Adenine Dinucleotide by its Binding with both D-Amino Acid Oxidase Apo-Protein and Benzoate (Dr Kunio Yagi, Takayuki Ozawa and Minoru Harada), 1938
Change of Cosmic Rays in Space (Prof H V Neher), 423
Change (Malignant), with Deoxyribonucleic Acid from Rat Sarcoma and Hepatoma An Attempt to produce (Dr J G Bearn), 824
Change (Simultaneous), in both Differential and Interference Distances of Chiasmata (Dr J Yanney Wilson), 207
Change (Technological) Personnel Management and (Institute of Personnel Management Annual Conference), 1614
Changes in Adenosine Di- and Tri-phosphate Concentrations in the Early Stages of the Action of Yeast on Glucose (Dr J O Laws and Dr L H Stickland), 1246
Changes in the Climate of the Atlantic–European Area and Secular Solar Activity (Z Gregor and L Křivsky), 682
Changes in Fluorescence in a Frog Sartorius Muscle following a Twitch (Prof Britton Chance and Frans Jobsis), 195
Changes in Keratin and the Analogy with Muscle Contraction Permanent Set, Supercontraction and Urea-Bisulphite Solubility—the Proton-Transfer Nature of some (Dr P T Speakman), 339
Changes in the Lacunal Parenchyma of *Mimosa pudica* in Diurnal and Nocturnal Conditions (Hideo Toriyama), 737
Changes in the Level of Serum Protein during Treatment of Kwashiorkor (Dr Olumbe Bassir), 2019
Changes in Purine Nucleotides of Red Lateral Muscle of Rainbow Trout (Tsuneyuki Saito, Ken-ichi Arai and Toshikatsu Yajima), 1415
Changes (Chemical), associated with Diapause in the European Corn Borer, *Ostrinia nubilalis* (Hbn) (Lepidoptera Pyralidae), (J A Mutchmor and J H Maruzek), 1077
Changes (Cosmic Ray Energy Spectrum) Evidence for, during a Forbush Decrease (K W Ogilvie and M M Winn), 888
Changes (Electrical Resistivity), observed in a Semiconducting Diamond after Heat Treatment (R E Mutch and Dr F A Raal), 1857
Changes (Hybridization) Effect of, on the Bond Energies of Carbon–Carbon Single Bonds (J E Bloor and S Gartside), 1313
Changes (Metabolic), induced in Mammalian Erythrocytes by Whole-Body X-Irradiation (Prof D A Rappoport and B W Sewell), 846
Changes (Post-activation), at the Mammalian Neuromuscular Junction (J I Hubbard), 1945
Changes (Quantitative), in γ-Aminobutyric Acid induced by Low Temperature in Rice Plants (F Zsoldos), 280
Changes (Seasonal), in the Œstrous Response by the Ovariectomized Ewe to Progesterone and Œstrogen (Prof J I Raeside and M F McDonald), 458
Changing Concepts of Management Relationships in Industry—some (British Institute of Management and the Ministry of Labour Conference on), 156
Chantrenne, Prof H Enzymes (Present Status of the Investigation of the Mechanism of Protein Synthesis), 688
  Protein Biogenesis 1198
Chapman, Dr Brian The Profession of Government—the Public Service in Europe, 127
  The Profession of Government, 1087
Chapman, Prof Kent M , and Pearce, Prof James W Vagal Afferents in the Monkey, 1237
Chappell, Dr J B Enzymes—Kinetics and Chemistry, *review*, 388
Characteristics of Glucose-6-phosphate Dehydrogenase from Normal and Primaquine-sensitive Erythrocytes (Glucose-6-phosphate Dehydrogenase and Human Erythrocytes), (Dr Henry N Kirkman), 1291
Characteristics (Chromatographic and Biological) of Fish and Frog Neurohypophysial Extracts (Active Principles of the Neurohypophysis of Cold-blooded Vertebrates), (B T Pickering and Prof H Heller), 1463
Characterization (A Partial Chemical), of Maize Coleoptile Cell Walls prepared with the Aid of a Continually Renewable Filter (Prof Aleksander Kivilaan, Teofila C Beaman and Robert S Bandurski), B A 81
Characters associated with Parasitism in Gram-Positive Bacteria (Dr B A Bisset), B A 29
Characters (Complex) Heterosis and the Genetics of (Watkin Williams), 527
Charcoal (Activated) Carbonization of Coals in the Presence of (Studies of Coal), (R L Bond, A M Godridge, A R Murnaghan, D H Napier and D J Williams), 425
Charcoal and Clays (Activated) Insecticidal Effects of (S K Majumder, K S Narasimhan and V Subrahmanyan), 1165
Chargaff, Prof Erwin (Horowitz, Dr Jack, and) Massive Incorporation of 5-Fluorouracil into a Bacterial Ribonucleic Acid, 1213
Charges Research and Development, in Civil Nuclear Power, 406
Charges of the Electron, Proton and Neutron A Comparison of the (A M Hillas and T E Cranshaw), 892 , (Prof H Bondi and Dr R A Lyttleton), 974

Charig, Dr A J (Francis, Dr G H, and) Return of, from the British Museum (Natural History) Expedition to South Peru, 1687
Charing Cross Hospital Medical School, London Appointment of A H J Rains to the chair of surgery, 322
Charities and Kindred Bodies Report of the Committee on the Rating of, 1343
Charles, R J Atomic Mechanisms of Fracture (Dependence upon Time of the Strength of Silicate Glasses under Static Loading), 324
Charleston, W A G Awarded a Research Training Scholarship by the Animal Health Trust, 771
Charlton, T M Engineering Statics, *review*, 1674
  Theory of Beams, *review*, 1976
Charnley, John Biomechanics (Nature of Lubrication in Animal Joints), 513
Charnockites A Re-interpretation of (A P Subramaniam), 321
Chars (Low-Temperature) Smoke Emission from Coal and (Studies of Coal), (D Finch), 426
Chatt, Dr J, and others Structure of α-Hydroxyacetylene Complexes of Platinum (II), 526
Chattaway, Dr F W, and others Effect of Steroids and related Compounds on the Growth of Dermatophytes, 1731
Chavez, Carlos Elected an Honorary Member of the American Academy of Arts and Sciences, 410
Cheddar Cheese Tallowy Discoloration in—Fat Oxidation and Trace Metals in Cheese (F Bishop), 1295, Fat Oxidation and Haematin Systems in Cheese (C G Rammell), 1296
Cheese Fat Oxidation and Haematin Systems in (Tallowy Discoloration in Cheddar Cheese), (C G Rammell), 1296
Cheese Fat Oxidation and Trace Metals in (Tallowy Discoloration in Cheddar Cheese), (F Bishop), 1295
Cheese (Cheddar) Tallowy Discoloration in—Fat Oxidation and Trace Metals in Cheese (F Bishop), 1295, Fat Oxidation and Haematin Systems in Cheese (C G Rammell), 1296
Cheesman, Dr D F Appointed to the University of London readership in biochemistry at Bedford College, 595
Chelating Theory (Copper), of their Mode of Action Plant-Growth Substances and the (Dr C H Fawcett) 796
Chemical Abnormality in Haemoglobin *G* (Dr Robert L Hill and Dr Herbert C Schwartz), 641
Chemical Activities of *E coli* adsorbed on a Resin, 'Dowex-1' (Tsutomu Hattori and Choseki Furusaka), 1566
Chemical Aeronomy Proceedings of the Conference sponsored by the Geophysics Research Directorate, Air Force Cambridge Research Center, Cambridge, Mass, 1956 (edited by M Zelikoff), *review*, 1011
Chemical Analysis Classical, *review* by Dr William I Stephen, 1756
  Soil (Prof M L Jackson), *review* by J M Bremner, 1093
Chemical Analysis of Foods and Food Products (Dr Morris B Jacobs), third edition, *review* by Dr V H Booth, 1347
Chemical Changes associated with Diapause in the European Corn Borer, *Ostrinia nubilalis* (Hbn) (Lepidoptera Pyralidae), (J A Mutchmor and J H Maruzek), 1077
Chemical Characterization (A Partial), of Maize Coleoptile Cell Walls prepared with the Aid of a Continually Renewable Filter (Prof Aleksander Kivilaan, Teofila C Beaman and Robert S Bandurski), B A 81
Chemical Control of Eelworms in Strawberries (R S Pitcher), 25
Chemical Dosimeter (A Sensitive), for Ionizing Radiation (Prof Gerald Oster and Dr Barret Broyde), 545
Chemical Effect of Ethylene during the Storage of Peas (Prof Frank A Lee), 462
Chemical Effect of Gene Mutation Human Haemoglobin *E*—the (Abnormal Human Haemoglobins), (Dr J A Hunt and Dr V M Ingram), 870
Chemical Energy Conversion of Light into, in Photosynthesis (Prof Daniel I Arnon), 10, *errata*, 1613
Chemical Engineering in Britain Progress of (Sir Hugh Beaver), 408
Chemical Engineering at Leeds, 1106
Chemical Engineering Scheme for a Full-time Course in (Institution of Chemical Engineer, 856
Chemical Engineering Practice (edited by Herbert W Cremer and Trefor Davies), Vol 6, Fluid Systems II, *review* by Prof J M Coulson 132
Chemical Engineers, Institution of Presidential Address (Sir Hugh Beaver), 408
  Scheme for a Full-time Course in Chemical Engineering, 856
Chemical Industry, Society of Fifth Chance Memorial Lecture (Dr W M Hampton), 772
  Fifth Levinstein Memorial Lecture (L H Williams), 1915
Chemical Industry, Society of (Food Group) Symposium on Enzymes in the Food Industry, 1366
Chemical Institute, Royal Australian Election of C E C Nicholls as president, 1106
Chemical Kinetics and Reactivity Some Problems in (N N Semenov), Vol I (translated by Michael Boudart), *review* by Dr T M Sugden, 299
Chemical Laboratory, National Retirement of Dr D D Pratt from the directorship, 1610
  Appointment of Prof J S Anderson as director, 1610
  Report for 1958, 1779
Chemical Nature of a Plant-Virus Inhibitor from Rice (W A Jones, M Jacobson and R P Kahn), 1146
Chemical Observation Phylogeny of the Genus *Aniba* Aubl—a Comparative Morphological and (Walter B Mors, Otto Richard Gottlieb and Ida de Vattimo), 1589
Chemical Oceanography, *review* by F A J Armstrong, 299
Chemical Processing of Nuclear Fuels (Dr F S Martin and Dr G L Miles), *review* by Dr J E Littlechild, 1346
Chemical Reactions (Fast), in Solution (Deutsche Bunsengesellschaft fur Physikalische Chemie and the Max-Planck Gesellschaft Colloquium on), 1453
Chemical Reactions (Fast), in Solution (Bunsengesellschaft fur physikalische Chemie and the Max-Planck Gesellschaft Colloquium on), 1453
Chemical Society Publication of a translation of the Russian *Zhurnal Neorganicheskoi Khimii* under the title *Russian Journal of Inorganic Chemistry*, 319
  Research Fund Grants, 857
  Proceedings of a Symposium on Steric Effects in Conjugated Systems, held at the University, Hull, 1958 (edited by Dr G W Gray), *review* by Dr G Eglinton, 1522
Chemical Studies (Metabolic and), of 'Myleran'—Formation of 3-Hydroxytetrahydrothiophene-1,1-dioxide *in vivo*, and Reactions with Thiols *in vitro* (Dr J J Roberts and Dr G P Warwick), 1288
Chemical Warfare Pugwash International Conference of Scientists—Statement on Biological and, 1018
Chemicals from Petroleum The Future of (L H Williams), 1915
Chemie (Physikalische), Deutsche Bunsengesellschaft fur, and the International Union of Pure and Applied Chemistry) Symposium on Thermodynamics, 1606
Chemie (Physikalische), Deutsche Bunsengesellschaft fur, and the Max-Planck Gesellschaft Colloquium on Fast Chemical Reactions in Solution, 1453
Chemisorbed Films in Electron Emission Microscopy Field Effects on (R J Hill and P W M Jacobs), 895
Chemistry Advanced Analytical (Prof Louis Meites and Prof Henry C Thomas), *review* by W I Stephen, 1525
  Analytical (edited by M T Kelley), Vol I, *review* by G W C Milner, 1524
  Analytical (A G Jones) *review* by Dr A M G Macdonald, 1677
  Awards of new Fellowships in, for 1959-60 (Ramsay Memorial Fellowships Trustees) B A 16
  Chymia—Annual Studies in the History of, Vol 5 (edited by Henry M Leicester), *review* by Prof J R Partington, 1900
  Comprehensive Analytical (edited by Prof Cecil L Wilson and David W Wilson), Vol Ia, Classical Analysis, *review* by Dr William I Stephen, 1756
  Heterocyclic (Prof Adrien Albert), *review* by Dr F. G Mann, 216
  Heterocyclic, *review* by Dr F G Mann, 1758
  Modern Inorganic, *review* by Dr D W A Sharp, 1756
  Old, *review* by Prof J R Partington, 1900
Chemistry at Bedford College, London, 1913
Chemistry at the Royal College of Science and Technology, Glasgow, 233
Chemistry in the Eighteenth Century (Dr Andrew Kent), 1452
Chemistry, Royal Institute of Meldola Medal for 1960, 1192
  Index of Chemistry Films, *review*, 1902
  Monographs for Teachers, No 1, Principles of Electrolysis (Prof C W Davies), *review* by Dr V Gold, 1902, No 2, Principles of Oxidation and Reduction (Dr A. G Sharpe), *review* by Dr V Gold, 1902
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Chemistry of Clothing (British Association for the Advancement of Science, Section B (Chemistry), Symposium on), 849
Chemistry of Glasses, Physics and (Society of Glass Technology), 855
Chemistry of Heterocyclic Compounds Vol 13, *s*-Triazines and Derivatives (edited by Edwin M Smolin and Lorence Rapoport), *review* by Dr F G Mann, 1758
Chemistry of Natural Products Vol 1, The Alkaloids (K W Bentley), Vol 2, Mono- and Sesquiterpenoids (P de Mayo), Vol 3, The Higher Terpenoids (P de Mayo), *review* by Prof A J Birch, 754
Chemistry of the Non-Metals Newer Developments in the (Kingston Technical College Course of Lectures on), 1915
Chemistry of Phosphorus, *review* by Dr F G Mann, 389
Chemistry in the Preservation of Antiquities (British Association for the Advancement of Science, Sections B (Chemistry) and H (Anthropology), Discussion on), 585
Chemistry of Propellants (Combustion and Propulsion Panel of the Advisory Group for Aeronautical Research and Development Discussion on), 778
Chemistry of Proteins The Structure and (Commonwealth Scientific and Industrial Research Organization Symposium on), 1276
Chemistry of Synthetic Drugs (May's), revised and rewritten by Dr G Malcolm Dyson, in consultation with Dr Percy May, fifth edition, *review* by F R Batchelor, 1597
Chemistry of Vegetable Tannins—Being the Papers presented at a Symposium held in the University, Cambridge, 1956, under the auspices of the Society of Leather Trades' Chemists, *review* by Dr A I Scott, 1832
Chemistry (Agricultural), in Aberystwyth, 317
Chemistry (Analytical) *Talanta* Medal for outstanding contributions to, 856
Chemistry (Analytical), at Birmingham, 679
Chemistry (Analytical), in Nuclear Reaction Technology Third Conference on, 26
Chemistry (Biophysical) Progress in Biophysics and (edited by Prof J A V Butler and Prof B Katz), Vol 9, *review* by P A Merton, 1092
Chemistry (Carbohydrate) Advances in (edited by Melville L Wolfrom in association with R Stuart Tipson), Vol 13, *review* by Dr Alfred Gottschalk, 662
Chemistry (Enzyme) Outlines of (Dr J B Neilands and Dr Paul K Stumpf), second edition, *review* by Dr Edwin C Webb, 1759
  Proceedings of the International Symposium on (Tokyo and Kyoto, 1957), (Science Council of Japan, under the auspices of the International Union of Biochemistry), *review* by Dr J B Chappell, 388
Chemistry (High Polymer) New Techniques in (Bradford Institute of Technology Course in) 1845
Chemistry (Inorganic), Russian Journal of (A translation of the Russian *Zhurnal Neorganicheskoi Khimii*, published by the Chemical Society), 319
Chemistry (Inorganic), and Radiochemistry Advances in (edited by H J Emeleus and A G Sharpe), Vol 1, *review* by Dr D W A Sharp, 1756
Chemistry (Organic) Progress in (edited by Dr J W Cook), Vol 4, *review* by Dr K H Overton, 1439
Chemistry (Polymer) Recent Progress in (Prof H Mark), 156
Chemistry (Polysaccharide) Application of the Mass Spectrometer to (Dr P A Finan and Dr R I Reed), 1866
Chemistry (Pure and Applied), International Union of Meeting of the Commission on Geochemistry, 1193
  Election of members of the Commission on Geochemistry, 1193
  Election of Prof C W Correns as president for 1960 of the Commission on Geochemistry, 1193
Chemistry (Pure and Applied), International Union of (Committee of the Analytical Chemistry Section) Nomenclature in Titrimetric Analysis, 1686
Chemistry (Pure and Applied), International Union of (Commission on Macromolecules) International Symposium on Macromolecules, 1689

Chemistry (Pure and Applied), International Union of (Deutsche Bunsengesellschaft fur Physikalische Chemie and the) Symposium on Thermodynamics, 1606
Chemistry (Textile) Recent Developments in (Bradford Institute of Technology, the Bradford Chemical Society and the Yorkshire Council for Further Education Symposium on), 1845
Chemistry Films Index of (Royal Institute of Chemistry), *review*, 1902
Chemistry and Biochemistry of Natural Products Steric Aspects of the (Biochemical Society Symposium on), 947
Chemistry and Pharmacology of 16-Acetyl Digitalinum Verum (Z Kanda, Prof A Sekiya, K Katayama, A Okano and T Miki), 1414
Chemistry and Taxonomy in the Dipterocarpaceae (Dr E C Bate-Smith and Dr T C Whitmore), 795
Chemotherapeutic Activity (Antiviral), of Isatin β-thiosemicarbazone in Mice infected with Rabbit-pox Virus (D J Bauer and F W Sheffield), 1496
Chemotherapy The Strategy of—Eighth Symposium of the Society for General Microbiology, 1958 (edited by S T Cowan and E Rowatt), *review* by Prof H Berry, 133
Chemotropic Response from Photopositive Domination in a Scolytid Beetle Release by Flight Exercise of a (Prof Kenneth Graham), 283
Cheng, Chung-Chih, and others Transistor Electronics, *review* by J W R Griffiths, 838
Cheng, Dr Ping-yao High Molecular Weight Ribonucleic Acids from the Nuclei of Calf Thymus, 190
Chenopodium (Tourn) L (Genus) Extreme Sensitivity of Germination and Photoperiodic Reaction in the (Dr Bruce G Cumming), 1044
Cherries (Sour and Sweet) Occurrence of Leuco-Anthocyanin in (Dr Kuang C Li), 1935
Cherry, Prof Colin From Microphone to Ear, *review*, 841
Chervinsky, J (Yashouv, A , and) Hybrids of *Tilapia nilotica* x *T galilea*, 1739
Cherwell, Lord The Prof—a Personal Memoir of (Sir Roy Harrod), *review* by Prof R V Jones, 1752
Chester, V E Effect of Oxygen on Endogenous Metabolism of a Respiratory-deficient Brewer's Yeast, 1956
Chevallaz, Dr G At the 139th Annual Meeting of the Swiss Society for Natural Sciences (Preparations for the Swiss National Exhibition at Lausanne in 1964), 1454
Chevallier, A , and Manuel, S Biological Effects of Low Doses of Ionizing Radiations (Drop in the Ascorbic Acid Content of almost all Tissues, particularly the Spleen), 1112
Chew, Prof G F Nuclear Forces and the Few-Nucleon Problem (The Primary Two-Nucleon Interaction), 1113
Chhotani, O B (Roonwal, Dr M L , and) New Neotropical Element (*Anoplotermes*) in Indian Termite Fauna, 1967
Ch'iang The Customs and Religion of the (D C Graham), B A 15
Chiasmata Simultaneous Change in both Differential and Interference Distances of (Dr J Yanney Wilson), 207
Chicago Natural History Museum Fieldiana, Botany, Vol 30, No 2, Orchids of Peru (C Schweinfurth), 409
    Fieldiana, Botany, Vol 24, Part I, Flora of Guatemala (Paul C Standley and Julian A Steyermark), 771
Chiche, P , and Pregermain, S Coal Science (Ultra-fine Structure of Coals and Chars), 413
Chick, D R Ionization Phenomena in Gases (Design and Engineering of the Machine to be known as *Sceptre IV*), 1356
Chick A Chimaeric Duck with the Head of a (Tamikazu Seno and Saburo Saito), B A 78
Chick Blastoderm (De-embryonated) 8-Azaguanine Inhibition of Haemoglobin Synthesis in (B R A O'Brien), 376
Chick Embryo Inhibition of Skeletal Formation in the, following Administration of Tetracycline (Gerrit Bevelander, Hiroshi Nakahara and Gloria K Rolle), 728
Chick Embryos injected with Adult Chicken Blood Cytological Identification of Proliferating Donor Cells in (P M Biggs and L N Payne), 1594
Chick Growth Factors Unidentified (J A Wakelam and W P Jaffe), 272
Chick Mesenchymal Tissue Production of Serum Albumin and of Globulins by, and by HeLa Tumour Tissue in Culture (Y Abdel-Samie, Prof E Broda, G Kellner and W Zischka), 361, *erratum*, 943
Chicken Blood (Adult) Cytological Identification of Proliferating Donor Cells in Chick Embryos injected with (P M Biggs and L N Payne), 1594
Chicken Embryos Combined Effects of Cortisone and Insulin on Developing (Dr Pietro de Franciscis and Prof Walter Landauer), 101
Chieffi, G , and others Haemoglobin Pattern of the Cyclostome *Pertromyzon planeri* during the Course of Development, 1325
Child, K J , and others Spectrophotofluorometric Assay of Griseofulvin, 364
Child (School) The Health of the—Fifty Years of the School Health Service (Report of the Chief Medical Officer of the Ministry of Education for 1956 and 1957), 98
Children (Handicapped), in Britain—their Problems and Education (compiled by W A Axford), (Library Association), 1777
Chilling Requirements of Peach Seeds Gibberellic Acid and the (the late Prof Margaretha G Mes), 2034
Chimaeric Duck with the Head of a Chick (Tamikazu Seno and Saburo Saito), B A 78
China, Dr W E The Insect Pests of Cotton in Tropical Africa, *review*, 1011
China The Development of Iron and Steel Technology in (Dr Joseph Needham), *review* by Prof F C Thompson, 1830
    A History of Iron and Steel in, *review* by Prof F C Thompson, 1830
Chinese Scientific Literature, 681
Chisholm, A Awarded an Overseas Scholarship by the Royal Commission for the Exhibition of 1851, 409
Chisholm, Dr Brock, and others Statement on Biological and Chemical Warfare, 1018
Chisholm, Margaret, and Jacob, Dr L Current Fluctuations in the Oxide Cathode, 1058
Chlorella Tabular Comparative Data for the Low- and High-Temperature Strains of (Dr Constantine Sorokin), 613
Chlorella pyrenoidosa Macromolecular Components of (Philip Newmark, Jack D Stephens, James B Curry and Gail L Bower), 963
Chloride (Anhydrous Aluminium) A New Method for Working up Processing Mixtures containing (Dr T Szell and A Furka), 117, *erratum*, 595
Chloride (Mercuric) Reaction of, with Plasmalogen (Dr William T Norton), 1144
Chloride (Polyvinyl), and Polyvinyl Acetate Separation of, by Chromatographic Methods (W J Langford and D J Vaughan), 116
Chloride (Sodium) Intake and Urinary Histamine in Adrenalectomized Rats (Dr T Bjuro and Dr H Westling), 1241
Chloride (*d*-Tubocurarine) Increase by Chlorothiazide of the Paralysing Activity of (Prof W Ferrari, G L Gessa and G Sangiorgi), 1235
    Induced Tolerance to, in the Cat (Fiona Acheson and Dr R J M Fry), 1409
Chlorides (Phosphonitrilic) Polymerization of (Prof Thomas R Merton), 899
Chlorine in Muscle Tissues Determination of, by Neutron Activation Analysis (Dr Jonas Bergstrom), 1504
Chloroform A Concave Concentration Gradient of Ethanol in, employed in Elution of Lipids from Silicic Acid (J J Wren), 816
Chloroplast Pigments of Deuterated Green Algae (Harold H Strain, Henry L Crespi and Joseph J Katz), 730
Chloroplasts (Isolated) Destruction of Carotenoids in (J Friend and T O M Nakayama), B A 66
Chlorothiazide Increase by, of the Paralysing Activity of *d*-Tubocurarine Chloride (Prof W Ferrari, G L Gessa and G Sangiorgi), 1235
Chlorpromazine Abolition by, of the Inhibiting Effect of Iproniazid on the Depletion of Adrenal Catechol Amines induced by Reserpine (F Camanni Dr G M Molinatti and M Olivetti), B A 65
    Effect of, on Crocker Sarcoma and Ehrlich Ascites Carcinoma (Prof M Chorazy), 200
    Effect of, upon Isolated *d*-Amino-Acid Oxidase Systems (Dr Andrew Lasslo and Anne L Meyer), 1922
Chlorpromazine with Flavins Complex Formation of (Dr Kunio Yagi, Takayuki Ozawa and Toshiharu Nagatsu), 982
Chmurzynska, Wanda, and Wojtczak, Lech Interaction between Thiourea and Insect Polyphenoloxidase, 1941
Cholesterol in House Fly Reproduction Rôle of (Ronald E Monroe), 1513
Cholesterol (Plasma), in the Rat Effect of Dietary Fat and Extent of Blood Sampling on the Level of (I Coleman and J M R Beveridge), 1039
Cholesterol (Serum), in Rats Dietary Protein and (A P de Groot), 903
Choline Acetylase Action of Ganglion Blocking Drugs on (Dr J E Gardiner) B A 71
Cholinergically Innervated Sweat Glands Response of, to Adrenaline and Noradrenaline (Dr David P C Lloyd), 277
Chollet, P (Tardif, H P , and) Dynamic and Static Deformation of Armco Iron, 1917
Chondroitin Sulphates Biosynthesis of (J B Adams), 274
Chopra, Prof C H Cytochemical Study of Mitochondrial Structure, 656
Chorazy, Prof M Effect of Chlorpromazine on Crocker Sarcoma and Ehrlich Ascites Carcinoma, 200
Chowdhury, K A Origin and Dispersal of Flowering Plants (Angiosperms in various Tertiary Floras of India), 1201
Chree (Charles) Lecture of the Physical Society (Sir Edward Bullard) ,954
Christensen, B Asexual Reproduction in the Enchytraeidae (Olig), 1159
Christensen, Dr E H Ergonomics, its Place in Industry, B A 21
Christian, C S Appointed a member of the Executive of the Australian Commonwealth Scientific and Industrial Research Organization, 1984 , work of, 1984
Christie, Dr Jesse R Plant Nematodes, *review* by Dr W G Inglis, 1349
Christmas, A N Promoted to Deputy Chief Scientific Officer and appointed director of Guided Weapons (Techniques) at the Ministry of Aviation Headquarters, 1775 , work of, 1775
Christmas Holiday Lecture of the Institution of Electrical Engineers (G G Gouriet), 1535
Christmas Lectures (Science Museum, London), 1535
Christmas Lectures (Zoological Society of London), 1535
Christmas Lectures of the Royal Institution (Dr T E Allibone), 1613
Christophe, Jean, and others Increased Circulating Insulin-like Activity in Obese-Hyperglycaemic Mice, 61
Chromatic Responses Significance of the Time Relations of Humorally Co-ordinated (Dr A K Kent), 2027
Chromatin (Sex), in Cultured Human Tissues (Dr Charles P Miles), 477
Chromatin (Sex), ('Chromoleme'), in the Perkinje Nerve Cells of some Mammals (Nylceo Marques de Castro and Wilson da Silva Sasso), 293
Chromatin (Sex) Pattern in the Male Rat Effect of Sexual Maturation and Castration on the (St Zsifkovits, Ch Mehes and C Jobst), 1239
Chromatium Influence of Carotenoids on the Infra-Red Spectrum of Bacteriochlorophyll in (Dr J A Bergeron and Dr R C Fuller), 1340
Chromatograms (Paper) Autoradiography of Tritium-labelled Compounds on (Dr A W Rogers), 721
    Detection of 2-4-Dinitrophenyl Amino-Acids on (Dr A H Maddy), 1397
Chromatographic Columns (Packed and Capillary Gas) Comparison of Efficiency and Separating Power of (Dr J H Purnell), 2009
Chromatographic Fractionation of Rat Tail Tendon Collagen (Alexander Kessler, Hyman Rosen and Dr Stanley M Levenson), 1640
Chromatographic Identification of the Antilipaemic X Factor of the Unsaponifiable Fraction of Crude Vegetable Oils (Prof M C Nath, A Saikia and B I Uppin), 1635
Chromatographic Method (A Paper-), for the Determination of Suitable Buffer Systems for Countercurrent Distribution (Andrzej Waksmundzki and Edward Soczewinski), 977
Chromatographic Methods Separation of Polyvinyl Chloride and Polyvinyl Acetate by (W J Langford and D J Vaughan), 1116
Chromatographic Reviews—Progress in Chromatography, Electrophoresis and related Methods (edited by Michael Lederer), Vol I, *review* by Dr R Consden, 1436
Chromatographic Separation (Gas), of Long-chain Fatty Acid Methyl Esters on Polyvinyl Acetate (Irwin Hornstein, L E Elliott and P F Crowe), 1710
Chromatographic Separation (Paper), of Components of Rose Bengal Labelled with Iodine-131 (Fausto W Lima and Rômulo R Pieroni), 1065
Chromatographic and Biological Characteristics of Fish and Frog Neurohypophysial Extracts (Active Principles of the Neurohypophysis of Cold-blooded Vertebrates), (R T Pickering and Prof H Heller), 1463

Chromatographical Observations (Physical and), of γ-Irradiated Potato Starch Granules (Akira Mishina and Ziro Nikuni), 1867
Chromatographie Papier- (Dr Friedrich Cramer), vierte Auflage, *review* by Dr R Consden, 1436
Chromatographie (Papier-) Handbuch der (herausgegeben von Dr I M Hais und Dr K Macek), Band I, Grundlagen und Technik, *review* by Dr R Consden, 1436
Chromatography Comparative Effects of Heat on, and Ultra-violet Absorption of Deoxyribo- or Ribo-Nucleic Acids (Dr Saul Kit), 36
  'Eddy' Diffusion in (J Calvin Giddings), 357
  Gas (Gas Chromatography Discussion Group and the Hydrocarbon Research Group of the Institute of Petroleum Symposium on), 327
  Keeping Up to Date with, *review* by Dr R Consden, 1436
  Volatile Liquid Partition (Dr Roger S Porter and Dr Julian F Johnson), 978
Chromatography of Calcium Phosphate Purification of Herpes Simplex Virus by (Janice Taverne and Peter Wildy), 1655
Chromatography (Gas) Analysis of Permanent Gases by, using a Radioactive Ionization Type Detector (V Willis), 894
  Carrier Gas and Sensitivity in (E M Fredericks, M Dimbat and F H Stross), B A 54 , (Dr N H Ray), B A 54
  Progress in (C G Scott), 1199
  Sensitivity of Catharometers in, and the Thermal Conductivity of Binary Gas Mixtures (A B Littlewood), 1631
  Use of Coated Tubing as Columns for (Prof Albert Zlatkis and H R Kaufman), 2010
Chromatography (Gas Solid) Separation of the *Meta*- and *Para*-Isomers of the Xylenes, Cresols and Toluidines by (M A Hughes, D White and Prof A L Roberts), 1796
Chromatography (Glass-Paper) Specific and Sensitive Assay Method for Vasopressin and Oxytocin using (Akira Arimura and Prof Joseph F Dingman), 1874
Chromatography (Paper) Applications of, to Systematics—Recombination of Parental Biochemical Components in a *Baptisia* Hybrid Population (Dr R E Alston and Dr B L Turner), 285
Chromatography (Paper), of Cell Fragments (A T Wilson), 2016
Chromatography (Paper), of Corticosteroids at Room Temperature (J Tuzson), 1937
Chromatography (Paper), and Paper Electrophoresis A Manual of (Richard J Block, Emmett L Durrum and Gunter Zweig), second edition, *review* by Dr R Consden, 1436
Chromatography (Quantitative Paper), based on the Sub-Micro Titration of Derivatives containing Nitro Groups (L Blom and J Caris), 1313
Chromatography, Electrophoresis and related Methods Chromatographic Reviews—Progress in (edited by Michael Lederer), Vol I, *review* by Dr R Consden, 1436
Chromatography Columns (Gas–Liquid) Unexpected Formation of Volatile Compounds on (C Weurman and J Dhont), 1480
Chromium Distribution around Grain Boundary Carbides found in Austenitic Stainless Steel (B E Hopkinson and K G Carroll), 1479
Chromium Ribonucleoprotein from Bovine Liver (Dr W E C Wacker and Dr B L Vallee), 1399
Chromogenic Strain (A Non-Gummy), of *Azotobacter vinelandii* (J A Bush and Prof P W Wilson), 381
'Chromoleme' (Sex Chromatin), in the Purkinje Nerve Cells of some Animals (Nylceo Marques de Castro and Wilson da Silva Sasso), 293
Chromoprotein Pigments of some Cryptomonad Flagellates (Photoreactive Pigments in Flagellates), (Dr Mary Belle Allen, Dr Ellsworth C Dougherty and Dr John J A McLaughlin), 1047
Chromosomal Evolution in Eutherian Mammals (Prof Robert Matthey), 1329
Chromosomal Synthesis of Ribonucleic Acid as shown by Incorporation of Uridine labelled with Tritium (G Pelling), 655
Chromosome Breakage with Plant Pigments (Dr Arun Kumar Sharma and Arati Gupta), 1821
Chromosome Complement of Spontaneous Leukaemia in *AKR* Mice (H F Stich, R Wakonig and Dr A A Axelrad), 998
Chromosome Numbers in *Solidago* (J R Beaudry and D L Chabot), 236
40-Chromosome Variant in *Solanum nigrum* L (U K Rai), 1587
Chronic Morphine Administration (Acute and) Noradrenaline and Adrenaline in the Rat Brain during, and during Withdrawal (Dr Lars-M Gunne), 1950
Chronic Schizophrenia (Dr Thomas Freeman, John L Cameron and Andrew McGhie), *review* by Prof Martin Roth, 487
Chronowicz, A W Appointed lecturer in civil engineering at the University of Leeds, 684
Chum Salmon Two Haemoglobins in (K Hashimoto and Prof F Matsuura), 1418
Churches, Central Council for the Care of, and the Society for the Protection of Ancient Buildings Report on the Conservation of English Wallpaintings, 1119
Chvapil, Dr M , and Hurych, J Hydroxylation of Proline *in vitro*, 1145
Chymia—Annual Studies in the History of Chemistry, Vol 5 (edited by Henry M Leicester), *review* by Prof J R Partington, 1900
Chymotrypsin Reactivity and Inter-relationship of Intermediates in the Hydrolysis of *p*-Nitrophenyl Acetate Catalysed by (Mario A Marini and Prof George P Hess), 113
Ciba (A R L), Ltd New Research and Production Facilities at (R F Webb), 601
Ciba Foundation Ten Years Report for 1949-1959, 681
  Symposium on Medical Biology and Etruscan Origins (edited by G E W Wolstenholme and Cecilia M O'Connor), *review* by Madelaine Smith, 1348
Ciba Fellowships for 1960-61, 1613
Ciccarone, P , and others Biological Effects of Low Doses of Ionizing Radiations (An Effect which occurred soon after the Comparatively Low Dose of 150 r (whole-body) to Rats), 1112
Cinnamic Acid and Hydroxy-Cinnamic Acids Metabolism of, by *Lactobacillus pastorianus* var *quinicus* (Dr G C Whiting and Dr J G Carr), 1427
Circuits (Extracorporeal) Release of Adenosine Triphosphate and Serotonin from Injured Cellular Blood Elements in (Dr H S S Sarajas, Dr R Kristoffersson and Dr M H Frick), 1127
Circuits (Transistor) Use of the Silicon Resistor in the d c Stabilization of (J T Zakrzewski and D H Mehrtens), 811
Circulating Blood Cells Synthesis of Haem by (Peggy Clark and Dr R J Walsh), 1730
Circulating Ferritin Pathophysiological Effects of (Yoshio Oki), 1944
Circulating Insulin-like Activity in Obese-Hyperglycaemic Mice Increased (Jean Christophe, Yves Dagenais and Jean Mayer), 61
Circulation (Droplet), and Interfacial Disturbances in Gas—Liquid Systems (Dr C Ramshaw and Dr J D Thornton), 719
Circumpolar Arctic Flora (Dr Nicholas Polunin), *review* by R D Meikle, 1347
Citrate Agar (Simmons's) Production of Colicines in (Dr J Paravassiliou), 1339
Citrate-Dithionite Reagent (Neutral) Aluminium extracted by (W M H Saunders), 2037
Citric Acid Colorimetric Estimation of (Prof R E Macdonald and W E Waterbury), 988
Citric Acid Production by *Aspergillus niger* Effect of Sulphanilamide on (K V Rajagopalan, R Radhakrishnamurthy and P S Sarma), 461
Citrullus vulgaris (Water Melon) α-Amino-β-(pyrazolyl-N) Propionic Acid, a New Amino-Acid from (Dr F F Noe and Dr L Fowden), B A 69
Citrus Red Mite *Panonychus citri* (McG) A Suspected Virus Disease of the (Dr Kenneth M Smith, G J Hills, F Munger and J E Gilmore), 70
Citterio, Dr C (Mascitelli-Coriandoli, E and) Intracellular Thioctic Acid and Coenzyme A following Vanadium Treatment, 1641
City of London College, in collaboration with the Plastics Institute Lectures on Plastics, 508
City of Paris Medal Awards, B A 16
Civil Nuclear Power Research and Development Charges in, 406
Civil Service, Scientific Special Promotions, 858
Civil Service Commissioners Ninety-third Annual Report (1958-59), 1278
Clapham, Prof A R , and others Excursion Flora of the British Isles, *review* by P Falk, 1093
Claridge, R F C , and Maddock, Dr A G Annealing of Recoil Damage by Ultra-Violet Light, 1932
Clark, F Le Gros Age and the Working Lives of Men, 318
Clark, Dr J E , and Heath, Prof O V S Auxin and the Bulbing of Onions, 345
Clark, M L Awarded a Nature Conservancy Research Studentship for postgraduate training in ecology (zoology), 156
Clark, Peggy, and Walsh, Dr R J Synthesis of Haem by Circulating Blood Cells, 1730
Clark, Dr W C (Latty, James E , and) Forces between Titanium Dioxide Pigment Particles, 49
Clark-Lewis, Dr J W , and Mortimer, P I Occurrence of 4-Hydroxypipecolic Acid in *Acacia* Species, 1234
Clarke Dr Donald A , and others Effect of Bacillus Calmette-Guerin Infection on Transplanted Tumours in the Mouse, 291
Clarke, Prof E , and Turner, A *Obituary* of Prof G O Sherrard, 1531
Clarke, Dr E G C Identification of Phenazocine, a Potent New Analgesic, 451
Clarke, Dr F J P Special Ceramics (Properties of certain Oxide Crystals —Room-temperature Ductility of Single Crystals of Magnesium Oxide), 1115
Clarke, G , and others Occurrence of 3-Indolylacetic and 3-Indolecarboxylic Acids in Tomato Crown-Gall Tissue Extracts, 825
Clarke, J W , and McTurk, G Some Experiments in Rice's Blue Material, 2014
Class (Social) The Psychology of (Maurice Halbwachs), translated by Claire Delavenay, *review* by Prof T S Simey, 754
Classes (Different Size), in Non-diabetic Humans of Varying Ages Actual Distribution of the Number and Volume of the Islets of Langerhans in (Bo Hellman), 1498
Classical Analysis Linear Operations and, *review* by Prof L S Goddard, 1763
Classical Chemical Analysis, *review* by Dr William I Stephen 1756
Classical Optics Concepts of (Dr John Strong), *review* by Dr J E Geake, 130
Classics of Nutrition, *review* by Dr Leslie J Harris, 484
Classification of Elements Periodic (A A Clifford), 2012
Classification (A Revised), of the Ludlovian Succession at Ludlow (C H Holland, J D Lawson and V G Walmsley), 1037
Classification, Concept-formation and Language (British Society for the Philosophy of Science Symposium on), 1193
Claxton, J H , and others Growth Responses to Selenium in Lambs, 251
Clay, Dr Theresa Evolution of Host–Parasite Relationships (Evolution of Host–Parasite Relationships in the Mallophaga of Birds), 762
Clay Minerals (Clay Minerals Group of the Mineralogical Society Discussion on), 779
Clay Minerals (X-Ray Analysis Group of the Institute of Physics Discussion on), 780
Clay Products Permanent Moisture Expansion of, on Natural Exposure (J S Hosking and H V Hueber), 1373
Clays of Japan Mineralogical Study on (Dr Toshio Sudo), *review* by Dr D M C MacEwan, 1439
Clays (Activated Charcoal and) Insecticidal Effects of (S K Majumder, K S Narasimhan and V Subrahmanyan), 1165
Clays (Straining) Swelling Forces in (E L Greacen), 1695
Clayton, R B A Simplified Method for the Culture of *Blatella germanica* under Aseptic Conditions, 1166
Clayton, Dr Y M , and others Human Precipitins against Common Pathogenic and Non-Pathogenic Fungi, 1328
Cleavage (Early), of the Zebra Fish Variations in (A W Marrable), 1160
Cleavage (Side-Chain), during the Reaction of Epinephrine and Norepinephrine with Ethylene Diamine Evidence of (Dr Louis-P Joly and Dr Guy Nadeau), 1483
Cleave, Dr J P At the Annual General Meeting and Conference of the Mathematical Association (Translation of Languages by Machine), 33
Cleghorn, T E A 'New' Human Blood Group Antigen, Sw_a, 1324
Clein, L J Appointed lecturer in mental health at Queen's University, Belfast, 1613
Clements Dr A N Appointed lecturer in physiology and biochemistry at the University of Southampton, 595
Clerical Salaries Analysis 1958 (Office Management Association), 698
Clezy, Dr P S Reaction of Formyl Porphyrins with Acetone-Hydrochloric Acid, 1142

Clezy, Dr P S (Barrett, J , and) Selective Oxidation of Tetrapyrrole Side-Chains, 1988
Clifford, A A Periodic Classification of Elements, 2012
Clifford, H T Vivipary in *Eleusine indica* (L) Gaertn , 1888
Climate of the Atlantic–European Area and Secular Solar Activity Changes in the (Z Gregor and L Křivsky), 682
Climatic Significance (Pleistocene), of Calcretes and Ferricretes (Dr R J Mason, A B A Brink and K Knight) 568
Clinical Biochemical Method (Dr A L Tarnoky), *review* by Dr D S H W Nicol, 576
Clinical Biochemists, Association of Election of Officers, 857
Clinical Metabolic Research Enzymic Activities of Human Skeletal Muscle Mitochondria—a Tool in (Dr L Ernster, Dr D Ikkos and Dr R Luft), 1851
Clock (A Biological), in *Neurospora* (Growth Patterns in *Neurospora*), (C S Pittendrigh, Dr V G Bruce, N S Rosensweig and M L Rubin), 169
Clocks Animal (British Association for the Advancement of Science, Section D (Zoology), Symposium on), 763, 1534
Clocks (Non-linear) Stochastic Rectification of (David G Kendall), 1476
Clonal Selection Theory of Acquired Immunity (Sir Macfarlane Burnet), *review* by Dr J H Humphrey, 753
Clones (Virulent), of *Fusarium oxysporum* f *cubense* A Rapid and Simple Pathogenicity Test for Detecting, using Seedlings of *Musa balbisiara* (Dr R H Stover), 1591
Cloning Cells of Higher Plants A New Technique for Isolating and (Ludwig Bergmann), 648
Clothes Moth, *Tineola bisselliella* (Humm) A Reduced Triphosphopyridine Nucleotide-linked Cystine Reductase in the (R F Powning and H Irzykiewicz), 1230
Clothing The Chemistry of (British Association for the Advancement of Science, Section B (Chemistry), Symposium on), 849
Clots (Human Standard) Urokinase-Induced Fibrinolysis of (Dr Kuro N von Kaulla), 1320
Clouds (Noctilucent) Polarization of Light from (Georg Witt), 1618
Clouds (Solar Corpuscular) Apparent Observation of, by Direct Continuous-Wave Reflexion (Dr John D Klaus and W Reed Crone), 965
Cloudsley-Thompson, Dr J L Animal Clocks, 763, 1534
Clover Effect of *Rhizobium* Polysaccharide on the Formation of Polygalacturonase in Lucerne and (H Ljunggren and G Fahraeus), 1578
Clover Sickness Dagger Nematodes associated with a (F C Peacock), 123
Clover (Red), *Trifolium pratense* L Floral Initiation and its Relationship to Growth-Stage in (J L Stoddart), 559
Clover-free Diet Implications of Restricting Cows to a, in order to Reduce the Strontium Content of Milk (Dr David Purves), 1408
Clover Cyst Nematode *Heterodera trifolii* Goffart, 1932 Giant Eggs of the (Roland H Mulvey), 1662
Clowes, F A L Reorganization of Root Apices after Irradiation, 1025
Clunies-Ross, Sir Ian *Obituary* by Dr F W G White and D A Gill, 230
Clusters (Globular) A Search for Neutral Atomic Hydrogen in (Dr Morton S Roberts), 1555
Cnidian Medicine Ancient Egyptian and (Robert O Steuer and J B de C M Saunders), *review* by Dr Douglas Guthrie, 662
Coagulase Influence of on the Growth of Staphylococci in Normal Human Serum (Dr K Wlodarczek and Dr J Jeljaszewicz), 1514
Coagulase (Staphyloccal-free) Activation of, by Purified Human Prothrombin (G Haughton and E S Duthie), 116
Coagulating System (Blood), and the Physiological Anticoagulating System Interrelations between the (Prof P A Kudrjashov), 454
Coal Studies of (Staff of the British Coal Utilisation Research Association) —Carbonization of Coals in the Presence of Activated Charcoal (R L Bond, A M Godridge, A R Murnaghan, D H Napier and D J Williams), 425 , Smoke Emission from Coal and Low-Temperature Chars (D Finch), 426
Coal and Coal Extracts Biological Properties of (Dr A A Mills), 1885
Coal Board, National Grant of £4,310 to the University of Leeds, for six research projects in mining, 1534
  Grant of £1,150 to the Department of Physical and Inorganic Chemistry in the University of Bristol, for a study of carbon surfaces and surface complexes by infra-red spectroscopy, and £1,100 for a study of reactivity of carbon surfaces with oxygen, 1613
Coal Board, National (North-Eastern Division) Grant of £3,000 to the University of Leeds, for research in mining, 1108
Coal Extracts Biological Properties of Coal and (Dr A A Mills), 1885
Coal Preparation Second Symposium on (Department of Mining, University of Leeds, 1957), *review* by Prof S G Ward, 1601
Coal Science Third Biennial International Conference on 412
Coal Utilization Research Association, British (Staff of the) Studies of Coal—Carbonization of Coals in the Presence of Activated Charcoal (R L Bond, A M Godridge, A R Murnaghan, D H Napier and D J Williams), 425 , Smoke Emission from Coal and Low-Temperature Chars (D Finch), 426
Coal during Carbonization at Different Heating Rates Number of Free Radicals in (J Smidt and Prof D W van Krevelen), 719
Coal and Low-Temperature Chars Smoke Emission from (Studies of Coal), (D Finch), 426
Coals Carbonization of in the Presence of Activated Charcoal (Studies of Coal), (R L Bond, A M Godridge, A R Murnaghan, D H Napier and D J Williams), 425
Coals (Bituminous) Structure of—Evidence from Distribution of Hydrogen (Dr P H Given), 980
Coast Erosion and Accretion (British Association for the Advancement of Science, Sections E (Geography) and K (Botany), Discussion on), 499
Coast and Geodetic Survey, United States To erect a Geodetic Marker at the South Pole, 1612
Coastal Waters of Japan (1959) Concentration of Caesium-137 in the (Noboru Yamagata), 1813
Coat-Shedding in a Tropical Breed of Hair Sheep Light Regulation of (R B Symington), 1076
Coated Tubing as Columns for Gas Chromatography Use of (Prof Albert Zlatkis and H R Kaufman), 2010
Coates, Colonel John Boyd (editor-in-chief) Surgery in World War II, Neuro-surgery, Vol 1, *review* by J E A O'Connell, 1676
Coating of Red Blood Cells with Antigenic Substances (Dr K Deutsch), 278
Cobalt-60 and Caesium-137 Translocation of, by Fungi in Agar and Soil Cultures (Dr Erna Grossbard and Dr D R Stranks), 310
Cobalt Acetate Tetrahydrate Temperature Variation of the Principal Magnetic Moments of Co^{++} Ions and the Asymmetry of the Crystalline Electric Field in (Dr Bhagawati Charan Guha), 50
Co^{++} Ions Temperature Variation of the Principal Magnetic Moments of, and the Asymmetry of the Crystalline Electric Field in Cobalt Acetate Tetrahydrate (Dr Bhagawati Charan Guha), 50
Cobaltic Oxide Pellets Effect of, on the Vitamin B_{12} Content of Ewes' Milk (L I Hart and E D Andrews), 1242
Cobb, James C , and others The Geological Time-Scale, B A 62
Cocconi, Giuseppe, and Morrison, Philip Searching for Interstellar Communications, 844
Cochrane, Prof Vincent W Physiology of Fungi, *review* by Dr J L Harley, 85
Cockburn, Dr R Appointed chief scientist of the Ministry of Supply, 938 , work of, 938
Cocoa (*Theobroma cacao* L), in Ghana New Pests of, following Applications of Insecticides (P F Entwistle, C G Johnson and E Dunn), 2040
Coconut Palm The (Dr K P V Menon and Dr K M Pandalai), *review* by Prof C W Wardlaw, 1760
Coconut Seedlings Albinism in (Dr K M Pandalai and R V Pillai), 1163
Coconuts, *review* by Prof C W Wardlaw, 1760
Co-dehydrogenases (Apo- and) Interaction of Streptomycin and Dihydrostreptomycin with (Prof K Michalska), 987
Codner, R C , and Platt, B C Light-induced Production of Carotenoid Pigments by *Cephalosporia*, 741, *erratum*, 1108
Coefficients (Rotational Friction), of Models of Tobacco Mosaic Virus and the Size of the Virus Particle (Dr A J Haltner and Dr B H Zimm), 265
Co-enzyme Rôle of the, in the Stabilization of Glyceraldehyde-3-phosphate Dehydrogenase (P Elodi and G Szabolcsi), 56
Coenzyme A Intracellular Thioctic Acid and, following Vanadium Treatment (E Mascitelli-Coriandoli and Dr C Citterio), 1641
Coenzyme Q (Dr T Ramasarma), 1368
Coenzyme for Histidine Decarboxylase Pyridoxal Phosphate, a (S Ono and Prof P Hagen), 1143
Coetzee, Prof J N , and Sacks, T G Lysogeny in the Genus *Proteus*, 1340
Coffea Recherches sur les Affinités Chromosomiques dans le Genre (J Bouharmont), 518
Coffea canephora Pierre Recherches sur l'Autostérilité du Caféier robusta (M Devreux, G Vallaeys, P Pochet et A Gilles), 518
Cohen, I Bernard (edited with a General Introduction by, assisted by Robert E Schofield) Isaac Newton's Papers and Letters on Natural Philosophy and related Documents, *review* by Dr M A Hoskin, 1570
Cohen, Prof John Chance and Probability (The Psychology of Luck), 498
Cohen, Dr J Appointed a lecturer in zoology at the University of Birmingham, 684, 1362
Cohen, M , and others Atomic Mechanisms of Fracture (Tensile Fracture of Mild Steels), 325
Coil Spring Federation Research Organization New Laboratories of the, 777
Coinage Metals (Cu, Ag, Au) Electron Spin Resonance and Divalency of some Dithiocarbamates of the (Tore Vänngard and Stig Åkerstrom), 183
Coins (Partially Distinguishable) Heads-Tails Statistics for Two (Gabriel Weinreich), 1825
Coke in Ironmaking Successful Use of (Meeting of the Iron and Steel Institute at the University of Birmingham and at Coalbrookdale to celebrate the 250th anniversary of the), 322
Coke Oven Managers' Association, the Institution of Gas Engineers and the British Coke Research Association Joint Meeting, 1778
Coke Research in Great Britain Progress in, 1778
Coke Research Association, British (Coke Oven Managers' Association, the Institution of Gas Engineers and the) Joint Meeting, 1778
Colaba and Alibag Observatories Retirement of S L Malurkar from the directorship, 1611
Cold World The Very, *review* by Prof J F Allen, 1260
Cold-blooded Vertebrates Active Principles of the Neurohypophysis of—Chromatographic and Biological Characteristics of Fish and Frog Neurohypophysial Extracts (B T Pickering and Prof H Heller), 1463 , Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464 , Arginine Vasotocin (Panayotis G Katsoyannis and Prof Vincent du Vigneaud), 1465
  Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from (Active Principles of the Neurohypophysis of Cold-blooded Vertebrates), (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464
Cole, Dr A R H , and Muller, G T A At the Second Australian Spectroscopy Conference (Stable Conformations of a Series of Methyl-*cyclo*-hexanols), 1196
Cole, G Coast Erosion and Accretion (Gathering and Stabilizing of Sands, Silts and Clays by Vegetation), 500
Cole, H H , and Cupps, P T (edited by) Reproduction in Domestic Animals, Vol 1, *review* by Dr S J Folley, 1091
Cole, L J Biological Effects of Low Doses of Ionizing Radiations (Effects of Single Exposures and 'Chronic' or Fractionated Radiation), 1113
Cole, L J , and Garver, R M Abrogation by Injected Mouse Blood of Protective Effect of Foreign Bone Marrow in Lethally X-Irradiated Mice, 1815
Cole, Dr M , and Borucka, Dr A Z Special Ceramics (Novel Replaceable Heating Element), 1116
Cole, W F , and Kroone, B Carbonate Minerals in Hydrated Portland Cement, B A 57
Coleman, G , and Elliot, W H Structure and Chemistry of Proteins (Synthesis of α-Amylase by *Bacillus subtilis*), 1277
Coleman, I , and Beveridge, J M R Effect of Dietary Fat and Extent of Blood Sampling on the Level of Plasma Cholesterol in the Rat, 1039
Coléoptères Curculionides (Faune de France, Vol 62), (Adolphe Hoffmann), troisiéme partie, *review* by R T Thompson, 573
Coleoptile Cell Walls (Maize) A Partial Chemical Characterization of, prepared with the Aid of a Continually Renewable Filter (Prof Aleksander Kivilaan, Teofila C Beaman and Robert S Bandurski), B A 81
Coles, D R Appointed lecturer in medicine at the University of Bristol, 322

Coles, Surg Lieut R R A, and Knight, J J Effect of Jet Aircraft Noise on Hearing, 1803
Colgate, Dr S A The Thermonuclear Processes (Hydrodynamic Stability Studies using High Current Pulses through Sodium), 241
  Ionization Phenomena in Gases (Linear and Toroidal Hard-core or Inverse Pinch), 1357
Colicine Production of, by Single Bacteria (H Ozeki, Dr B A D Stocker and Helène de Margerie), 337
Colicines in Simmons's Citrate Agar Production of (Dr J Papavassiliou), 1339
Colin, L (Weisbrod, S, and) Refraction of Very High Frequency Radio Signals at Ionospheric Heights, 119
Collagen The Optical Rotatory Power of (Dr R E Burge and R D Hynes), 1562
Collagen (Rat Tail Tendon) Chromatographic Fractionation of (Alexander Kessler, Hyman Rosen and Dr Stanley M Levenson), 1640
Colldahl, Helge, and others A New Method for Studying the Functioning of the Lungs, 372
College of Physicians of Philadelphia Alvarenga Prize for 1959 awarded to Dr Hilary Koprowski, 683
Colleges (Technical) Relationship between Industry and (Liverpool District of the Federation of British Industries Conference on), 1690
Colli, Walter (Raw, Dr Isaias, and) Crystalline Cytochrome b_5, 1798
Collinge, Dr B Appointed reader in physics in the University of Liverpool, 410
Collins, Prof H J Title of professor emeritus of civil engineering in the University of London conferred on, 508
Collision Broadening of Spectral Lines, 155
Collision Effects in Atomic Spectra (W R Hindmarsh), 155
Collisions (Automobile) Experiments on (Prof J H Mathewson), 237
Collison, Dr R, and Elton, Dr G A H Gelation (The Swelling of Starch), 863
Collocalia Echo-location among (Lord Medway), 1352
Colloid-storing Function of Histiocytes A Method for *in vitro* Investigation of the (Prof N Jancso, Aurelia Jancso-Gabor and J Balassy), 1070
Colman, J S (Nagabhushanam, A K, and) Carrion-Eating by Ophiuroids, 285
Colomina, M Thermodynamics (Experimental Thermochemistry), 1607
Colonial Development Corporation Annual Report for 1958, 680
  Report of the Committee of Enquiry into the Financial Structure of the, 1520
Colonial Medical Research Council Grant of £2,500 for two years to the University of Oxford, for the study of the sensory neurohistological changes in skin infected with leprosy, 1362
Colonial Office The Colonial Territories, 1958-1959, 1541
Colonial Territories, 1958-1959 (Colonial Office), 1541
Colorado Potato Beetle, *Leptinotarsa decemlineata* (Say) Common Attractant for the Tobacco Hornworm, *Protoparce sexta* (Johan) and the (Dr Robert T Yamamoto and Prof G Fraenkel), 206
Colorado State University Proceedings of the Third Symposium on Reproduction and Infertility (edited by F X Gassner, in association with Rue Jensen and H J Hill), *review* by Dr T Mann, 1434
Colored Lights (White and), and Darkness Behavior and Reactions of the Pacific Sardine, *Sardinops caerulea* (Girard), under the Influence of (Dr A S Loukashkin and Dr N Grant), 865
Colorimetric Determination of Elastin Some Improvements in (Dr V Scarselli), 1563
Colorimetric Estimation of Citric Acid (Prof R E Macdonald and W E Waterbury), 988
Colorimetric Methods of Analysis, including Photometric Methods (Dr Foster Dee Snell and Dr Cornelia T Snell, assisted by Dr Chester Arthur Snell), Vol 2A, *review* by J King, 1522
Colorimetry, *review* by J King, 1522
Colour The Reproduction of (Dr R W. G Hunt), *review* by Dr W S Stiles, 1092
Colour of the Iris of the Eye Association between, and Reaction to Dental Pain (Dr Philip R N Sutton), 122
Colour Centres produced by Radiation in Silica Gel (Harold W Kohn), 630, *erratum*, 1026
Colour-Image Synthesis with Two Unorthodox Primaries (Arthur Karp), 710
Colour Photography Kodak Scholarships in, 1915
Colour Photography of the Aurora (B P Sandford and P Heiser), 540
Colour Reactions of certain Phenols with Ehrlich's Reagent (Dr Cornelius Steelink), 720
Colour Reproduction, *review* by Dr W S Stiles, 1092
Colour Television (G G Gouriet), 1535
Colourability of Substituted Human Serum Proteins Modifications in Immunological Behaviour, Electrophoretic Mobility and (M Steinbuch, Dr J M Fine and A Battistini), 1571
Coloured Product of the Sakaguchi Reaction (Kshirod R Bhattacharya), 53
Colston Research Society Proceedings of the Tenth Symposium on the Structure and Properties of Porous Materials, held in the University of Bristol, 1958 (edited by D H Everett and F S Stone), *review*, 1525
Colter, Dr John S The Structure of Science (Viral Nucleic Acids), B A 9
Colter, Dr John S, and others Ribonucleases of Mouse Tissues and of the Ehrlich Ascites Tumour, 984
Columns for Gas Chromatography Use of Coated Tubing as (Prof Albert Zlatkis and H R Kaufman), 2010
Comar, Dr Cyril L Appointed associate editor of the *Journal of Nutrition*, 156
Comber, Dr R Effect on the Groundnut of Variations in Supply of Potassium, Calcium and Magnesium, 1003
Combined Effects of Cortisone and Insulin on Developing Chicken Embryos (Dr Pietro de Franciscis and Prof Walter Landauer), 101
Combined Use of Polymyxin and Acetone to obtain Cell-free Enzymes (J R Villanueva), 1565
Combustion Report of the seventh International Symposium on, 770
  A Method for Determining Carbon-14 by, using Calcium Carbonate (E C S Little), 900
Comet, Stig Awarded a Silver Medal of the City of Paris, B A 16
Comitato Nazionale per le Ricerche Nucleari, and others Symposium on the Biological Effects of Low Doses of Ionizing Radiations, 1111
Commerce Staff in Industry and—Management of Workers whose Skills are mainly Mental or Social rather than Manual (E. M Barling), 319
Commerce, Tyneside Association of Libraries for Industry and, 25
Commercial Control Two Threats to Broadcasting—Political and (H Carleton Greene), 661
Common Attractant for the Tobacco Horn-worm, *Protoparce sexta* (Johan) and the Colorado Potato Beetle, *Leptinotarsa decemlineata* (Say), (Dr Robert T Yamamoto and Prof G Fraenkel), 206
Common Laboratory Mammals Visual Pigments of some (Dr C D B Bridges), 1727
Common Pathogenic and Non-Pathogenic Fungi Human Precipitins against (Dr J Pepys, Dr R W Riddell and Dr Y M Clayton), 1328
'Common Strontium' (Anomalous), in Granite (W Compston and Dr P M Jeffery), 1792
Commoner, Prof Barry Replication of Tobacco Mosaic Virus—a Re-examination of Theories, 1998
Commoner, Prof Barry, and others Replication of Tobacco Mosaic Virus—Kinetics of Virus Protein and Ribonucleic Acid Biosynthesis, 1992
Commons, House of Third reading of the Nuclear Installations (Licensing and Insurance) Bill, 680
Commonwealth Educational Problems of the, 747
  University Co operation in the (Home Universities Conference 1959), 1613
Commonwealth, Universities of the Report of Proceedings of the Eighth Congress, Montreal, 1958, 1431
Commonwealth Agricultural Bureaux Appointment of A Perera as chairman of the Executive Council, 943
Commonwealth Education—the United Kingdom Contribution (Duncan Crow), 592
Commonwealth Education Liaison Committee (British) Establishment of a, 1361
Commonwealth Fund Harkness Fellowships for 1960, 857
Commonwealth Institute New building for the, 234
Commonwealth Scientific and Industrial Research Organization (Australian) Grant of 30,000 dollars from the Rockefeller Foundation, for special equipment for the new Division of Tropical Pastures, 93
  Grant of 100,000 dollars from the Rockefeller Foundation, for the Divisions of Plant Industry and of Entomology, 93
  Grant of 250,000 dollars from the Rockefeller Foundation, towards the cost of the radio telescope for the Division of Radiophysics, 93
  Formation of a Division of Mineral Chemistry, 237
  Appointment of Dr F W G White as chairman, 317
  Appointment of Dr R N Robertson as a full-time member of the Executive, 317
  Rural Research in C S I R O, 27, Fencing Posts in Australia, 320
  List of Divisions and Sections, 410
  Tenth Annual Report (1957-58), 1027
  Second Australian Spectroscopy Conference, 1195
  Symposium on the Structure and Chemistry of Proteins, 1276
  Retirement of D A Gill as chief of the Division of Animal Health and Production, 1532
  Appointment of Dr J M Rendel as chief of the Division of Animal Genetics, 1532
  Appointment of Dr T S Gregory as chief of the Division of Animal Health, 1532
  Appointment of Dr I W McDonald as chief of the Division of Animal Physiology, 1532
  Cunningham Laboratory of the, 1776
  Appointment of C S Christian and Prof L G H Huxley as members of the Executive, 1984
  Appointment of G B Gresford as secretary, 1985
  Appointment of W Ives as executive officer, 1985
Commonwealth Universities Yearbook, 1959 (Association of Universities of the British Commonwealth), *review*, 577
Commonwealth (British), Association of Universities of the Commonwealth Universities Yearbook, 1959, *review*, 577
Communication (Efficient), of Skills New Developments in Training—Five Studies in the (edited by Frank A Heller), 421
Communication Networks Synthesis of Linear (Wilhelm Cauer), second edition edited by Wilhelm Klein and Franz M Pelz (translated from the German by G E Knausenberger), *review*, 1525
Communication and Scientific Developments Mass Media of, 659
Communications The Critical Importance of Transport and (Sir Ewart Smith), B A 44
Communications (Interstellar) Searching for (Giuseppe Cocconi and Philip Morrison), 844
Compact Bone Distribution of Sodium in, as revealed by Autoradiography of Neutron-activated Sections (Prof J Vincent), 1332
Compaction of Briquettes (H R Gregory, D C Rhys Jones and J W Phillips), 120
Comparative Data (Tabular), for the Low- and High-Temperature Strains of *Chlorella* (Dr Constantine Sorokin), 613
Comparative Effects of Heat on Chromatography and Ultra-violet Absorption of Deoxyribo- or Ribo-Nucleic Acids (Dr Saul Kit), 36
Comparative Histology Textbook of (Dr Warren Andrew), *review* by Dr T Kerr, 752
Comparative Morphology of Vascular Plants (Adriance S Foster and Ernest M Gifford, Jr), *review* by Dr S Williams, 84
Comparative Morphological and Chemical Observation Phylogeny of the Genus *Aniba* Aubl —a (Walter B Mors, Otto Richard Gottlieb and Ida de Vattimo), 1589
Comparative Studies in Ultrastructure (Linnean Society of London Symposium on), 1445
Comparison of the Charges of the Electron, Proton and Neutron (A M Hillas and T E Cranshaw), 892 , (Prof H Bondi and Dr R A Lyttleton), 974
Comparison of Efficiency and Separating Power of Packed and Capillary Gas Chromatographic Columns (Dr J H Purnell), 2009
Comparison of Slime from Tomato and Banana Strains of *Pseudomonas solanacearum* (Dr W F Dudman), 1969
Compensation (Isostatic), and Mohorovičic Discontinuity, etc Depth of, in Continental and Oceanic Areas (J N Nanda), 629
Complement Release of Compounds containing Diaminopimelic Acid from *Vibrio metchnikovi* treated with Antibody and (Dr F Shafa and Dr M R J Salton), 1341
Complement (Chromosome), of Spontaneous Leukaemia in AKR Mice (H F Stich, R Wakonig and Dr A A Axelrad), 998

Complementation among the Sub-Genic Mutants in the *r*-Locus of *Drosophila melanogaster* (Dr O G Fahmy and Dr Myrtle J Fahmy), 1927
Complex (Enzyme-Substrate) Proof of the Formation of, by 'Crossing-Paper Electrophoresis' (Prof S Nakamura, K Takeo, I Sasaki and M Murata), 638
Complex (*Leiocephalus cubensis*), in Cuba and the Isla de Pinos Variation in Lizards of the (Albert Schwartz), 1107
Complex' ('Surface Membrane) Dissociation of the, in Atrophic Muscle Fibres (Dr R Birks, Prof B Katz and Dr R Miledi), 1507
Complex Carbohydrates Medical Aspects of (Prof M Stacey), B A 42
Complex Characters Heterosis and the Genetics of (Watkin Williams), 527
Complex Formation of Chlorpromazine with Flavins (Dr Kunio Yagi, Takayuki Ozawa and Toshiharu Nagatsu), 982
Complex Reaction in *Hyoscyamus niger* upon Night Interruption with Red Light (P J A L de Lint), 731
Complexes Histidine–Copper (II), (Dr D D Perrin), 1868
Complexes (α-Hydroxyacetylene), of Platinum (II) Structure of (Dr J Chatt, L A Duncanson and R G Guy), 526
Complexes (Metal), of Oxine and its Sulphonic Acid Stability of (Prof Adrien Albert and Prof Reino Nasanen), 449
Complexes (Montmorillonite) Birefringence of (R Greene-Kelly), 181
Complexes (Polynuclear), of Molybdenum (II), (Dr J C Sheldon), 1210
Complexing with Anionic Derivatives of Synthetic Polyglucoses Reduction of Toxicity of Cationic Macromolecules by (P T Mora, B G Young and M J Shear), 431
Components of Folic Acid Reductases Flavins as (Dr Beatriz M Braganca and U W Kenkare), 1488
Components of Rose Bengal Labelled with Iodine-131 Paper Chromatographic Separation of (Fausto W Lima and Rômulo R Pieroni), 1065
Components (Antigenic), from Isolated Nuclei Transplantation Immunity —Separation of (Andre Castermans and Andre Oth), 1224
Components (Macromolecular), of *Chlorella pyrenoidosa* (Philip Newmark, Jack D Stephens, James B Curry and Gail L Bower), 963
Components (Parental Biochemical), in a *Baptisia* Hybrid Population Applications of Paper Chromatography to Systematics—Recombination of (Dr R E Alston and Dr B L Turner), 285
Composition with an Electronic Computer Experimental Music— (Prof L A Hiller, Jr, and Leonard M Isaacson), *review* by Prof E G Richardson, 1754
Composition of some Fat-free Carcasses and Bodies of New Zealand Sheep (A H Kirton, M J Ulyatt and R A Barton), 1724
Composition of the Haemolymph of *Petrobius maritimus* Leach (Dr A P M Lockwood and Dr P C Croghan), 370
Composition of a Paraffin Wax Fraction from Tobacco Leaf and Tobacco Smoke (Dr W Carruthers and Dr R A W Johnstone), 1131
Composition of Sieve-Tube Sap (A J Peel and Dr P E Weatherley), 1955
Composition of Teichoic Acids from a Number of Bacterial Walls (Teichoic Acids from Bacterial Walls), (J J Armstrong, Prof J Baddiley, Dr J G Buchanan, A L Davison, M V Kelemen and F C Neuhaus), 247
Composition (Isotopic), of Boron (D C Newton, A C Tyrrell and J Sanders), 185
Composition (Spectral), of the Luminescence of the Euphausiid *Thysanoessa raschii* (Dr Brian P Boden and Dr Elizabeth M Kampa), 1321
Compound from *Olea europaea* Oleuropeic Acid, a New (Baruch Shasha and Prof Jeshaia Leibowitz), 2019
Compound (A Cardiolipin-like), in Rat Liver Mitochondria (G S Getz and W Bartley), 1229
Compound (A New Carbonyl), from *Piper methysticum* Forst (Prof Paul J Scheuer and Thomas J Horigan), 979
Compounds Effect of Steroids and related, on the Growth of Dermatophytes (Dr F W Chattaway, J D Townsley and A J E Barlow), 1731
  Heterocyclic (edited by Dr E H Rodd), (Chemistry of Carbon Compounds, Vol 4, Part B), *review* by Dr F G Mann, 1758
  High-Voltage Paper Electrophoresis of Aliphatic Amines and related (Dr D Gross), 1633
  New Antiadrenergic (A L A Boura, F C Copp and A F Green), B A 70
  Organic-Phosphorus (Bradford Institute of Technology Symposium on), 1688
  Phosphorus and its (John R Van Wazer), Vol I, Chemistry, *review* by Dr F G Mann, 389
  Six-Membered Heterocyclic Nitrogen, with Three Condensed Rings (C F H Allen, in collaboration with G M Badger, Brice Graham, G A Reynolds, James H Richmond, John R Thirtle, J A Van Allen and C V Wilson), *review* by Dr F G Mann, 216
  Stoichiometry of Bismuth Telluride and related (G Offergeld and J van Cakenberghe), 185
Compounds High Molecular (published in the Russian language by the Academy of Sciences of the U S S R), 410
Compounds containing Diaminopimelic Acid Release of, from *Vibrio metchnikovi* treated with Antibody and Complement (Dr F Shafa and Dr M R J Salton), 1341
Compounds (Aliphatic Carbonyl) A Correlation between the Shift in the Ultra-Violet Absorption Maxima and the Electronegativity of the Adjacent Atoms in some (Dr P Borrell), 1932
Compounds (Aromatic) Hydrogenolysis of Carbon-Oxygen Bonds in some, by Electrolysis (Dr P H Given and Dr M E Peover), 1064
Compounds (Carbon) Chemistry of (edited by Dr E H Rodd), Vol 4, Part B, Heterocyclic Compounds, *review* by Dr F G Mann, 1758
Compounds (Cyanocarbon Organic) Histochemical Use of the (Prof. John F Lhotka), 1153
Compounds (Ferrichrome) The Iron-Binding Centre of (Dr T Emery and Dr J B Neilands), 1632
Compounds (Foreign) Stimulatory Effect of, on Ascorbic Acid Biosynthesis and on Drug-Metabolizing Enzymes (Dr A H Conney and Dr J J Burns), 363
Compounds (Heterocyclic) The Chemistry of, Vol 13, *s*-Triazines and Derivatives (edited by Edwin M Smolin and Lorence Rapoport), *review* by Dr F G Mann, 1758
Compounds (Insoluble Protein-Tannin) Regeneration of Protein from (Dr W Mejbaum-Katzenellenbogen, W Dobryszycka, J Boguslawska-Jaworska and B Morawiecka), 1799
Compounds (Nucleotide–Peptide), of *Saccharomyces cerevisiae* (G Harris and J W Davies), 788
Compounds (Onium), in Brain Tissue Presence of certain, following Intravenous Administration to Rats (Prof Ruth R Levine), 1412
Compounds (Organic) Nitration of Hydrocarbons and other (A V Topchiev) translated from the Russian by Catherine Matthews, *review* by Prof M J S Dewar, 577
  Oxidation of (Symposium on, at Queen Mary College, London), 326
  Some Remarks on the Thermodynamic Properties of (Prof George S Parks), 1194
Compounds (Organic), in the Blood Post-Exposure Analysis of, by a Rapid Infra-red Technique (Dr R D Stewart, D S Erley, T R Torkelson and C L Hake), 192
Compounds (Organic), labelled with Isotopes of the Halogens, Hydrogen, Nitrogen, Oxygen, Phosphorus and Sulfur (Arthur Murray, III, and D Lloyd Williams), (Organic Syntheses with Isotopes, Part 2), *review* by Dr G Eglinton, 1830
Compounds (Quantitative Assay of), in Isolated, Fresh Nerve Cells and Glial Cells from Control and Stimulated Animals (Prof Holger Hyden), 433
Compounds (Substituted Phenoxy-), and other Translocated Herbicides Effects of, on the Rhizome of Bracken (Dr Elsie Conway and J A Forrest), 1416
Compounds (Tritium-labelled) Autoradiography of, on Paper Chromatograms (Dr A W Rogers) 721
Compounds (Volatile), on Gas–Liquid Chromatography Columns Unexpected Formation of (C Weurman and J Dhont), 1480
Comprehension of Scientific Journals Effects of Printing Types and Formats on the (E C Poulton), 1824
Comprehensive Analytical Chemistry (edited by Prof Cecil L Wilson and David W Wilson), Vol Ia, Classical Analysis, *review* by Dr William I Stephen, 1756
Compressible Fluid Flow Mathematical Theory of (Richard von Mises), (completed by Hilda Geiringer and G S S Ludford), *review* by Dr W P Jones, 485
Compressible Fluids Flow of, *review* by Dr W P Jones, 485
Compston, W, and Jeffery, Dr P M Anomalous 'Common Strontium' in Granite 1792
Computer in Production (Institution of Mechanical Engineers Discussion on), 1613
Computer (Electronic) Experimental Music—Composition with an (Prof L A Hiller, Jr, and Leonard M Isaacson), *review* by Prof E G Richardson, 1754
Computer Applications Report of the Proceedings of the fifth Annual Symposium on, 771
Computer Laboratory at the University of Liverpool, 1537
Computer Society, British First Conference (Dr A S Douglas), 945
Computers Digital (British Council Course on), 1450
Computers (Electronic) Music and, *review* by Prof E G Richardson, 1754
Computing High Speed (Dr S H Hollingdale), *review* by E M Deeley, 1832
Comsa, Dr J Effect of Adrenalectomy on the Hormone Content of the Thymus in the Rat, 279
  Influence of the Thymus upon the Egg-White Allergy in the Rat, 1726
Concave Concentration Gradient of Methanol in Chloroform employed in Elution of Lipids from Silicic Acid (J J Wren), 816
Concentrated Urea Solutions Effect of, on the Infectivity and Haemagglutinin of Vaccinia Virus (Prof J F McCrea and Jean O'Loughlin), 1497
Concentration of Caesium-137 in the Coastal Waters of Japan, 1959 (Noboru Yamagata), 1813
Concentration by Ion Flotation (Prof F Sebba), 1062
Concentration of Stearic Acid in Monolayers Adsorbed from Solution (George L Gaines, jun), 1139
Concentration (Elevated Plasma Sodium) Effects of, on Sodium and Potassium in the Erythrocyte of the Lizard *Trachysaurus rugosus* (Gray), (P J Bentley), 1403
Concentration (A Low), of certain Blood Constituents observed in Offspring of Alloxan-Diabetic Rabbits (Dr Otakar Sirek and Dr Anna Sirek), 456
Concentration Gradient (A Concave), of Methanol in Chloroform employed in Elution of Lipids from Silicic Acid (J J Wren), 816
Concentrations (Adenosine Di- and Tri-phosphate), in the Early Stages of the Action of Yeast on Glucose Changes in (Dr J O Laws and Dr L H Stickland), 1246
Concentrations (Maximum Permissible), of Radionuclides in Air and in Water for Occupational Exposure Maximum Permissible Body Burdens and (United States National Bureau of Standards, Handbook 69), 939
Concept-Formation and Language Classification, (British Society for the Philosophy of Science Symposium on), 1193
Conception of Evolution—Meeting in Paris (Dr J Ramsbottom), 859
Concepts of Classical Optics (Dr John Strong), *review* by Dr J E Geake, 130
Concepts (Changing), of Management Relationships in Industry—some (British Institute of Management and the Ministry of Labour Conference on) 156
Concepts (Constructive) Formalization of, *review* by Dr Hao Wang, 1435
Conceptual Foundations of Science, *review* by Gerd Buchdahl, 572
Concerning Human Understanding (Prof Nikunja Vihari Banerjee), *review* by Dr D J McCracken, 1571
Conchie, J, and Levvy, Dr G A Localization of β-Glucuronidase in Normal and Cancer Cells, 1709
Conchie, J, and Macdonald, D C Glycosidases in the Mammalian Alimentary Tract, 1233
Conchiolin Remnants in Mother-of-Pearl from Fossil Cephalopoda (Dr. Ch Gregoire), 1157
Conclusion Forty-seven Authors in Search of a, *review* by N W Pirie, 920
Condensation Processes for the Extraction of Radioactivity from Air (Rama), 1789
Conditions (Aseptic) A Simplified Method for the Culture of *Blatella germanica* under (R B Clayton), 1166
Conditions (Diurnal and Nocturnal) Changes in the Lacunal Parenchyma of *Mimosa pudica* in (Hideo Toriyama), 737
Conditions (Dry and Wet) Effect of X-Radiation on the Survival of Yeast in (A Mookerjee), 1502

Conditions (Experimental) Force-Feeding Fish under (Dr J M Dodd, Dr M H I Dodd and Dr C K Goddard), 1660
Conditions (Working), in Industry Fitting the Job to the Worker—a Survey of American and European (European Productivity Agency of the Organization for European Economic Co-operation, Project 335), 422
Condon, Dr E U , and Odishaw, Dr Hugh (edited by) Handbook of Physics, *review* by Prof H Lipson and S G Lipson, 298
Conduction Currents in Liquid *n*-Hexane under Microsecond Pulse Conditions (A Harry Sharbaugh and P Keith Watson), 2006
Conductivity (Thermal), of Binary Gas Mixtures Sensitivity of Catharometers in Gas Chromatography and the (A B Littlewood), 1631
Conen, Dr Patrick E , and others Establishment of Parenchymatous Spleno-Pulmonary Venous Anastomosis, 703
Conferences–Big or Small?, 835
Configuration of 10-Hydroxy-Δ^2-decenoic Acid Biological Origin and (Dr S A Barker, Dr A B Foster, D C Lamb and Dr L M Jackman), 634
Configurational Stability of Deoxyribonucleic Acid in Solution Influence of Counterion Association on the (F Ascoli, C Botre, V Crescenzi, A Mele and Prof A M Liquori), 1482
Confusion Function A Mathematical Model for Perception and a Theoretical (M Hammerton), 1668
Congeners of Pempidine with High Ganglion-blocking Activity (L Bretherick, G E Lee, E Lunt, W R Wragg and N D Edge), 1707
Congo Basin (Central) Nitrogen Content of Rain Water collected in the Humid (J Meyer and E Pampfer), 717
Congo Belge et du Ruanda-Urundi Carte des Sols et de la Vegetation du —6, Yangambi, Planchette 3, Lilanda, A, Sols , B, Vegetation (Notice explicative par P Gilson, P Jongen, A Van Wambeke et L Liben), (Institut National pour L'Etude Agronomique du Congo Belge), 27
Congo (Belgian) Haemoglobin *P* in a Family in the (Dr Paulette Dherte, Dr H Lehmann and Dr J Vandepitte), 1133
    Mammals of the, 155
    Soil Fungi in the, 236
Coniferous Seedlings Antibacterial Substances of, at Different Stages of their Development (R Vamos and L Vida), 915
Conjugated Systems Steric Effects in—Proceedings of a Symposium held at the University, Hull, 1958, by the Chemical Society (edited by Dr G W Gray), *review* by Dr G Eglinton, 1522
Conjugation in *Spirostomum* (Prof B R Seshachar and P B Padmavathi), 1510
Connective Tissue Diaphragms for Analysing the Development of (Prof Hans Selye), 701
Connell, Dr J J Flow Properties of Biological Systems (Measurements of Toughness and Firmness of Fish and of Fish Pastes and Jellies), 1540
Conney, Dr A H , and Burns, Dr J J Stimulatory Effect of Foreign Compounds on Ascorbic Acid Biosynthesis and on Drug-Metabolizing Enzymes, 363
Connor, J Appointed chairman of the National Committee for Geodesy and Geophysics, 1192
Conrad, Dr Herbert, and others Effects of Auxin and Gibberellic Acid on Growth of *Ulothrix*, 556
Conrad, Dr R Ergonomics, its Place in Industry (Mass Communication Systems), B A 20
Consciousness Perception, Attention and (Prof Magdalen D Vernon), B A 45
Consden, Dr R Electrophoresis in Theory and Practice *review*, 84
    Keeping Up to Date with Chromatography, *review*, 1436
Conservation of English Wallpaintings—being a Report of a Committee set up by the Central Council for the Care of Churches and the Society for the Protection of Ancient Buildings, 1119
Conservation in the Scottish Highlands (Scottish Branch of the Institute of Biology Symposium on), 1529
Conservation Foundation Living Resources of the Sea (Dr Lionel A Walford), *review* by Dr F S Russell, 129
Constable, F L Psittacosis Elementary Bodies, 473
Constant, Prof F Woodbridge Theoretical Physics, *review* by Dr R M Tennent, 1832
Constant (Equilibrium), of the Galactokinase Reaction and Free Energy of Hydrolysis of Adenosine Triphosphate (Dr M R Atkinson, Eleanor Johnson and Prof R K Morton), 1925
Constants (Lattice), of Copper dipyridine, dichloride and dibromide Influence of the Size of the Halogen Atom on the Difference between (Vladimir Kupcik and Slavomil Durovic), 1060
Constants σ^* (Taft's) An Attempt at Calculating the (Rudolf Zahradnik), 1865
Constituent (High-Temperature), in Mild Steel Surface-Hardened by Carbo-Nitriding Identification of the (M A H Howes, G T F Jay, K Sachs and D Wilkinson), 1312
Constituents (Blood) A Low Concentration of certain, observed in Offspring of Alloxan-Diabetic Rabbits (Dr Otakar Sirek and Dr Anna Sirek), 456
Constitution of Binary Alloys (Dr Max Hansen), second edition, prepared with the co-operation of Dr Kurt Anderko, *review* by Dr F C Thompson, 1765
Constitutional Diagrams of Uranium and Thorium Alloys (Frank A Rough and Arthur A Bauer), *review* by Dr D E R Hughes, 925
Constrictive Resistance in Thermal Equilibrium Influence of the Thomson Effect on the θ-φ Relationship for a (Dr W Davies), 975
Constructive Concepts Formalization of, *review* by Dr Hao Wang, 1435
Constructivity in Mathematics—Proceedings of the Colloquium held at Amsterdam, 1957 (edited by Prof A Heyting), *review* by Dr Hao Wang, 1435
Consulting Scientists, Association of Election of Officers, 508, 1777
Consumption and Refinery Production, 1957 and 1958 United Kingdom Petroleum Industry Statistics relating to (Petroleum Information Bureau), 855
Contact Catalysis (Dr R H Griffith and J D F Marsh), *review* by Dr E B Maxted, 1262
Contact with Lysozyme Appearance of Granules in the Cytoplasm of Tumour-Cell Cultures in (Dr Carlo Callerio), 202, *erratum*, 508
Continental and Oceanic Areas Depth of Isostatic Compensation and Mohorovičic Discontinuity, etc , in (J N Nanda), 629
Continual Creation of Matter The Steady-Rate Universe and the Deduction of (Prof V A Bailey), 537 , (Prof G Bondi), 537
Continually Renewable Filter A Partial Chemical Characterization of Maize Coleoptile Cell Walls prepared with the Aid of a (Prof Aleksander Kivilaan, Teofila C Beaman and Robert S Bandurski), B A 81
Continuous-Flow Culture of the Filamentous Mould *Penicillium chrysogenum* and the Control of its Morphology (S J Pirt and D S Callow), 307
Continuous-Wave Reflexion (Direct) Apparent Observation of Solar Corpuscular Clouds by (Dr John D Klaus and W Reed Crone), 965
Continuum Radiation from Jupiter Anomalous (Dr Eugene E Epstein), 52
Contour Analysis in Equatoria Meteorology Value of (D H Johnson and Dr H T Morth), 1372
Contractile Mechanism (Sliding Filament), in Tonic Smooth Muscles of Lamellibranch Molluscs Evidence for a (Dr Jean Hanson and Dr J Lowy), 286
Contraction of Striated Muscle A Peripheral Effect of the Bromide Ion on the (Dr D K de Jongh and H A Linnewiel), 1240
Contraction (Muscle) Permanent Set, Supercontraction and Urea-Bisulphite Solubility—the Proton-Transfer Nature of some Changes in Keratin and the Analogy with (Dr P T Speakman), 339
Contractions after Rest Potentiation of, in the Isolated Rat Ventricle Preparation (Dr R L Speirs), 66
Control Infestation—a Service to Agriculture and Food Storage (Ministry of Agriculture, Fisheries and Food), 941
    Pest, 941
    Quality (Quality Control Group of the Textile Institute Conference on), B A 16
    Two Threats to Broadcasting—Political and Commercial (H Carleton Greene), 661
Control of Antheridium Formation in the Fern Species *Anemia phyllitides*, (Dr Ulrich Näf), 798
Control of Government Research and Development Expenditure in Britain, 696
Control of Hatching in the Prediapause Eggs of *Aedes* Mosquitoes (Dr J D Gillett), 1621
Control of its Morphology Continuous-Flow Culture of the Filamentous Mould *Penicillium chrysogenum* and the (S J Pirt and D S Callow), 307
Control of Motor Behaviour Possible Rôle of Higher Proprioceptive Centres in the Perception of Visual Space and in the (Dr B Gurevitch), 1219
Control of Pests and Diseases Biological Problems arising from the (Institute of Biology Symposium on), 1100
Control of Pests and Diseases in Agricultural and Horticultural Crops (G L Hey and K Marshall), *review* by F C Bawden, 1258
Control of Public Expenditure, 857
Control (Automatic), International Federation of Members of the Executive Council, 1450
Control (Central), of Interactions between Behaviour Patterns in a Hemileucine Moth (Dr A D Blest), 1164
Control (Chemical), of Eelworms in Strawberries (R S Pitcher), 25
Control (Endocrine), in Crustaceans (Dr David B Carlisle and Sir Francis Knowles), *review* by Prof J H Welsh, 1761
Control (Genetic), of a Cyclic Growth Pattern in *Neurospora* (Growth Patterns in *Neurospora*), (Dr D R Stadler), 170
Control (Genetic), of Tryptophan Peroxidase-Oxidase in *Drosophila melanogaster* (Corrado Baglioni), 1084
Control (Hormonal) of Selective Feeding in Female *Calliphora erythrocephala* Meig (J Strangways-Dixon), 2040
Control (Maternal), of Ovariole Number in the Progeny of the Migratory Locust (F O Albrecht, M Verdier and R E Blackith), 103
Control (Pattern and), of Sclereid Formation in the Leaf of *Camellia japonica* (Donald F Foard), 1663
Control (Quality), in Electronics Sixth National Symposium on Reliability and, 1362
Control (*Stomoxys*), in Uganda, East Africa (H C M Parr), 829
Control (Treasury), of Expenditure (Observations of the Treasury), (Seventh Special Report from the Select Committee on Estimates, Session 1958-59), 696
Control Research (Pest) Advances in (edited by R L Metcalfe), Vol 2, *review* by F C Bawden 1258
Control and Instrumentation of Reactors Third Reactor School Course on the (Atomic Energy Research Establishment), 1026
Control and Stimulated Animals Quantitative Assay of Compounds in Isolated, Fresh Nerve Cells and Glial Cells from (Prof Holger Hydén), 433
Controlling (Growth-) Action of Human Serum in Cell Culture (Dr Kari Penttinen and Dr Erkki Saxén), 1570
Controversial Equation in Population Ecology (Dr A Milne), 1582 , (W B Yapp), 1582 , (Prof G C Varley), 1583
Conventional and Extra-Terrestrial Flight Behaviour in (Air Commodore W K Stewart), 578
Conversion of Ionospheric Virtual Height-Frequency Curves to Electron Density-Height Profiles (Dr J O Thomas and M D Vickers), (Radio Research Board, Special Report No 28), 1024
Conversion of Light into Chemical Energy in Photosynthesis (Prof Daniel I Arnon), 10, *errata*, 1613
Conversion of Salicylic Acid to Gentisic Acid and *o*-Pyrocatechuic Acid, all Labelled with Carbon-14, in Plants (Dr Ragai K Ibrahim and Prof G H N Towers), 1803
Conversion (Enzymic), of L-Rhamnulose to L-Fuculose in *Escherichia coli* (Laura Frontali and Giorgio Tecce), 1315
Convolvulus pluricaulis Chois Intraspecific Polyploidy and Evolution of Diverse Morphological Forms in (Dr S L Tandon and C P Mzalik), 481
Conway, Dr Elsie, and Forrest, J A Effects of Substituted Phenoxy-Compounds and other Translocated Herbicides on the Rhizome of Bracken, 1416
Cook, Dr A H Carbon Dioxide in Water, in Wine, in Beer and in other Beverages, *review*, 302
    Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 858 , work of 858
    Obituary of Sir Ian Heilbron 767
Cook, Dr C L At the Second Australian Spectroscopy Conference (Some Molecular Spectra excited by Shock Waves), 1197
Cook, Prof Elton S (Tokushige, Ambrose M , and) Thermal Decarboxylation of some Keto-Acid Hydrazones, 267

Cook, G B Radioactivation Analysis (Introductory Survey), 951
Cook, Dr J W (edited by) Progress in Organic Chemistry, Vol 4, *review* by Dr K H Overton, 1439
Cook, Dr R W E Light from the Corona Discharge, 1055
Cooke, A T K *Gloeosporium* in Apple Stem Wounds, 244
Cooke, Dr G W Availability of Plant Nutrients (Assessing the Nutrient Status of a Soil) 160
Cooksey, C J The Electric Arc in Welding, 1031
Coombs, Dr D S, and Hatherton, Dr T Palaeomagnetic Studies of Cenozoic Volcanic Rocks in New Zealand, 883
Coons, Dr A H (Sercarz, Dr E, and) Specific Inhibition of Antibody Formation during Immunological Paralysis and Unresponsiveness, 1080
Cooper, Dr L H N Polar Front Survey (Hydrography—North Atlantic Ocean), 1182
Cooper Union's Museum for the Arts of Decoration Paper-folding Exhibit, 770
Co-operation Partnership for Progress—International Technical (Annals of the American Academy of Political and Social Science, May 1959), *review* by R Brightman, 1673
Co-operation (University), in the Commonwealth (Home Universities Conference, 1959), 1613
Co-operative Phenomena (Prof Lars Onsager), 1195
Coops, J Thermodynamics (Experimental Thermochemistry), 1608
Co-ordinated Chromatic Responses Significance of the Time Relations of Humorally (Dr A K Kent), 2027
Coote, J L, and others Protein Biosynthesis and Oxidative Phosphorylation in Isolated Rat Liver Mitochondria, 165
Copernic Le Système du Monde—Histoire des Doctrines Cosmologiques de Platon a (Prof Pierre Duhem), Tome 10, *review* by Prof E J Dijksterhuis, 836
Copisarow, Dr Maurice *Obituary* by Prof T K Walker, 315
Copland, W O, and Delany, M J At the Conference of the Mammal Society of the British Isles (Small Mammals of South Rona), 30
Copley, Prof A L Flow Properties of Biological Systems (Nature of the Flow-curve of Blood in Glass Capillaries), 1540
Copley Medal for 1959 of the Royal Society awarded to Sir Macfarlane Burnet, 1189, 1833 , work of, 1833
Copp, F C, and others New Antiadrenergic Compounds B A 70
Copp, Dr J L Appointed senior lecturer in chemistry at Queen's College, Dundee, 684
Copper Effect of Polycyclic Aromatic Hydrocarbons on the Polarographic Maximum of (C E Searle), 1716
  Quadrupole Anti-Shielding Factor in (E A Faulkner) 442
  Swellings on the Shoots of Cacao Plants Deficient in (Dr R G Lockard, P Vamathevan and S Thamboo), 75
Copper-deficient Sheep Experiments on Wool from (R W Burley and F W A Horden), 1725
Copper-Catalyst Blocking Agent Inhibition of Rous I Sarcoma Metastases by a (Dr B M Jones), 1963
Copper (II) (Histidine–) Complexes (Dr D D Perrin), 1868
Cu, Ag, Au (Coinage Metals) Electron Spin Resonance and Divalency of some Dithiocarbamates of the (Tore Vanngard and Stig Åkerstrom), 183
Copper Chelating Theory of their Mode of Action Plant-Growth Substances and the (Dr C H Fawcett), 796
Copper dipyridine, dichloride and dibromide Influence of the Size of the Halogen Atom on the Difference between Lattice Constants of (Vladimir Kupcik and Slavomil Durovic), 1060
Copper-ethylene-diamine-*bis* (acetylacetone) in the Crystalline State Visible Absorption Spectra of (Animesh Chakravorty and Dr Sadhan Basu), 50
Copulation of *Glyptotendipes* (*Phytotendipes*) *paripes* Edwards (Dr Eric T Nielsen), 1252
Coregonus lavaterus Rete Mirabile in the Gas Bladder of (Goran Fahlen), 1001
Corlett, J Polar Front Survey (Biology—Zooplankton collected at Weather Stations *I* and *J*), 1184
Cormier, Leonard (edited by L V Berkner, in association with Gilman Reid, John Hanessian, Jr , and) Manual on Rockets and Satellites, *review*, 213
Corn (Field), *Zea mays L* , in Canada Isolation of the Antifungal Substance, 6-Methoxybenzoxazolinone, from (N J Whitney and C G Mortimore), 1320
Corn Borer (European), *Ostrinia nubilalis* (Hbn) (Lepidoptera Pyralidae) Chemical Changes associated with Diapause in the (J A Mutchmor and J H Maruzek), 1077
Cornish Scenery Preservation of, 1776
Corona (The Inner Solar), during June 1959 (G A Newkirk, G W Curtis, D K Watson, R Manning and J Shelby), 1308
Corona (Solar) Kellogg and Ney's Model of the (Dr D E Blackwell and Dr D W Dewhirst), 1120 , (Prof Edward P Ney and Prof Paul J Kellogg), 1122
Corona Discharge Light from the (Dr R W E Cook), 1055
Cormack, Dr A M Nuclear Forces and the Few-Nucleon Problem (Scattering of Nucleons by Light Nuclei at High Energy), 1113
Corpuscles of Stannius from Winter Flounder (*Pseudopleuronectes americanus*) to Synthesize Adrenocorticosteroids *in vitro* Failure of (Dr J G Phillips and Dr P J Mulrow), 558
Corpuscles (Red Blood) Effect of Polyphloretin Phosphate on the Suspension Stability of (Dr Bengt Fries), 62
Corpuscular Clouds (Solar) Apparent Observation of, by Direct Continuous-Wave Reflexion (Dr John D Klaus and W Reed Crone), 965
Correlation between Earth-Current and Geomagnetic Disturbance (V P Hessler and E M Wescott), 627
Correlation between the Intensity of the Umbra of Sunspots and Enhanced Radiation on 200 Mc /s (Per Maltby), 1391
Correlation between the Shift in the Ultra-Violet Absorption Maxima and the Electronegativity of the Adjacent Atoms in some Aliphatic Carbonyl Compounds (Dr P Borrell), 1932
Correlation (Photon) Polarization and Resolving Time Effects in (Dr E Brannen and Prof W Wehlau), 263
Correns, Prof C W Elected president for 1960 of the Commission on Geochemistry of the International Union of Pure and Applied Chemistry, 1193
Corrosion Study of, 1023
Corrosion Fatigue Life of Steel Relationship of *p*H to Aerobic (Dr Frederick J Radd, L Hugh Crowder and Louis H Wolfe), 2008
Cortex (Brain) *in vitro* Carbohydrate—Amino-Acid Inter-relations in (M M Kini and Prof J H Quastel), 252
Cortex (Visual), of the Unanaesthetized Cat Evoked Potentials in (Gabriel Horn and John Blundell), 173
Corticosteroids Paper Chromatography of, at Room Temperature (J Ruzson), 1937
Corticosterone Inhibition of Pyridine Nucleotide Oxidase from Heart Sarcosomes (P K Jensen), 451
Cortisol (Blood), in the Sheep—Normal Concentration and Changes in Ketosis of Pregnancy (H R Lindner), 1645
Cortisone and Insulin Combined Effects of, on Developing Chicken Embryos (Dr Pietro de Franciscis and Prof Walter Landauer), 101
Corynomycilic Acid Biosynthesis of, from Two Molecules of Palmitic Acid (Dr Mireille Gastambide-Odier and Prof E Lederer), 1563
Cosmic Electrodynamics (Dr J W Dungey), *review* by Prof V C A Ferraro, 1672
Cosmic Noise at Low Frequencies above the Ionosphere Measurement of (J P I Tyas, C A Franklin and A R Molozzi), 785
'Cosmic Ray Age' for the Iron Meteorite (Carbo) Calculation of a (Dr Royal R Marshall), 117
Cosmic Ray Energy Spectrum Changes Evidence for, during a Forbush Decrease (K W Ogilvie and M M Winn), 888
Cosmic-Ray Storm of February 11, 1958 North–South Anisotropy and Anticipatory Increase of Intensity associated with the (Dr V. Sarabhai and R Palmeira), 1204
Cosmic Rays in Space Change of (Prof H V Neher), 423
Cosmic Rays (Solar) Satellite Observations of (Pamela Rothwell and Carl McIlwain) 138
Cosmical Electrical Discharges The Temperature required for Nuclear Reactions in (Dr C E R Bruce), 2004
Cosmology History of, *review* by Prof E J Dijksterhuis, 836
Cosslett Dr V E X-Ray Microscopy and X-Ray Microanalysis, 860
Cost of Labour Turnover (British Institute of Management), 1110
Costa, Dr Luiz Macedo, and Csapo, Dr Arpad Asymmetrical Delivery in Rabbits, 144
Costoulas, A J At the Second Australian Spectroscopy Conference (Vibrational Assignment for Methyl-isothiocyanate), 1196
Cotton in Tropical Africa The Insect Pests of (E O Pearson, assisted by R C Maxwell Darling), *review* by Dr W E China, 1011
Cotton-Grass (*Eriophorum vaginatum* L) Mineral Uptake and Retention in (Gordon T Goodman and Donald F Perkins), 467, *erratum*, 1845
Cotton Industry Research Association, British Fortieth Annual General Meeting, 1846
  Open Days at the Shirley Institute, 1846
Cottonmouth Moccasin Venom labelled with Iodine-131 Distribution in the Mouse of Lethal and Sub-Lethal Doses of (Prof J F Gennaro, jun , and H W Ramsey), 1244
Cottrell, A H Atomic Mechanisms of Fracture (The Brittle–Ductile Transition), 325
Cotzias, George C, and others Thirst for Bile in Rats with Bile Fistulae, 1405
Coudert Prof Jean Action of *Trypanosoma cruzi* Extracts on Cancer Cells, 1115
Coulson, Prof J M Fluid Systems, *review*, 132
Coumarin Joint Action of Gibberellic Acid and, in Germination (A M Mayer), 826
Council for Nature Resolutions passed at the Annual General Meeting, 769
Countercurrent Distribution A Paper-Chromatographic Method for the Determination of Suitable Buffer Systems for (Andrzej Waksmundzki and Edward Soczewinski), 977
Countercurrent (South Equatorial), in the Pacific Ocean Evidence of a (Joseph L Reid, jun), 209
Counter-Current Distribution of Proteins in Aqueous Polymer Phase Systems (Per-Ake Ålbertsson and Ed Jacques Nyns), 1465, *erratum*, 1688
Counterion Association Influence of, on the Configurational Stability of Deoxyribonucleic Acid in Solution (F Ascoli, C Botre, V Crescenzi, A Mele and Prof A M Liquori), 1482
Counting (Bubble), on Low-Energy Particle Tracks (I R Birss), 1474
Countries (Under-developed) Assistance for, 1363
  Distribution of Scientific Publications in (Scientific Publications Council Discussion on), B A 22
  Management Problems in, 483
Country House and the Museum (Museums Association Discussion on), 598
Coursaget, J , and others (edited by) Biological Sciences, Vol 2 (Progress in Nuclear Energy, Series 6), *review* by Prof G Pontecorvo, 1902
  Medical Sciences, Vol 2 (Progress in Nuclear Energy, Series 7), *review* by Dr N M Blackett, 1766
Course on the Basic Techniques of Handling Radioisotopes (United States Atomic Energy Commission), 771
Course on the Control and Instrumentation of Reactors Third Reactor School (Atomic Energy Research Establishment), 1026
Course of Development Haemoglobin Pattern of the Cyclostome *Pertromyzon planeri* during the (M Adinolfi, G Chieffi and M Siniscalco), 1325
Course on Digital Computers (British Council), 1450
Course of Lectures on the Land of Britain—is it Used to the Best Agricultural Advantage? (Association of Agriculture and the Extra-Mural Department of the University of London), 1845
Course of Lectures on Newer Developments in the Chemistry of the Non-Metals (Kingston Technical College), 1915
Course of Lectures and Practical Work on Micro- and Semi-microchemical Methods (Norwood Technical College), 1845
Course in New Techniques in High Polymer Chemistry (Bradford Institute of Technology), 1845
Course in Statistics A First (Robert Loveday), *review* by J Durbin, 1008
Course on the Use of Radioisotopes in Agricultural Research (Ministry of Food and Agriculture of the Government of India, Food and Agriculture Organization of the United Nations, International Atomic Energy Agency and Unesco South East Asia Science Co-operation Office), 1451

Course (Full-time), in Chemical Engineering Scheme for a (Institution of Chemical Engineers), 856
Course (Regional Training), on Diagnosis, Improvement and Management of Salt-affected Soils (Unesco Middle East Science Co-operation Office), 1778
Course (Regional Training), for Laboratory Technicians (University Institute of Chemistry, Lahore), 857
Course (Sandwich), in Executive Development (Sheffield College of Technology), 235
Courses Postgraduate, 1959-60 (Imperial College of Science and Technology), 235
Courses at the Harwell Reactor School (Atomic Energy Research Establishment), 942
Courses (NATO Scientific) British Aid for, 406
Courses (Sandwich), for Teaching Technologists and Technicians (Dr P F R Venables), *review*, 1437
Covell, Sir Gordon Biological Problems arising from the Control of Pests and Diseases (Control of Human Diseases in Tropical Areas), 1101
Cowan, M J, and others Energy Transfer with special reference to Biological Systems (Chelates of Iron as Models for the Understanding of the Variations in Spectrum and Redox Potential of the Cytochromes), 690
Cowan, S T, and Rowatt, E (edited by) The Strategy of Chemotherapy —Eighth Symposium of the Society for General Microbiology, 1958, *review* by Prof H Berry, 133
Cowbird's Pituitary Prolactin in the, in relation to Avian Brood Parasitism (Prof E O Hohn), 2030
Cowen, Prof P N Splenic Siderosis in Mice treated with Dithiourethane, 366
Cowen, Prof P N (Ball, Dr J N, and) Urethane as a Carcinogen and as an Anaesthetic for Fishes, 370
Cowie, Dr J W The Geological Development of North America, *review*, 1600
Cowling, Prof T G Thermonuclear Research (Mechanical Effects of the Interaction between a Plasma and a Magnetic Field), 1017
Cows Implications of Restricting, to a Clover-free Diet in order to Reduce the Strontium Content of Milk (Dr David Purves), 1408
Cows treated with Penicillin Lowered Bactericidal Efficiency of Hydrogen Peroxide on Milk from (J Babad, D L Boros and F Baier), 292
Cox, Dr D R Planning of Experiments, 156
Cox, Prof E G Appointed secretary of the Agricultural Research Council, 1688
Cox, Dr G S (Block, B P and) Effect of Diet on the Blood Sugar and Liver Glycogen Level of Normal and Adrenalectomized Mice, 721
Cox, J D Thermodynamics (Experimental Thermochemistry), 1607
Cox, J T (Bridges, R G, and) Resistance of Houseflies to γ-Benzene Hexachloride and Dieldrin, 1740
Cox, Dr R A Polar Front Survey (Hydrography—Work of the R R S *Discovery II* in the North Atlantic Ocean), 1182
Cox, Dr R A, and Littauer, Dr U Z Secondary Structure of Ribonucleic Acid in Solution, 818
Cox, Ronald R Awarded a Perkin Centenary Scholarship, 237
Coyle, James Awarded a junior post-graduate agricultural research scholarship by An Foras Taluntais (the Agricultural Institute of Ireland), 1612
Crab (The Hermit), *Eupagurus bernhardus* The Sea Anemone (*Calliactis parasitica*) and (Dr D M Ross), 1161
Crack Behaviour at a Weld Structure Discontinuity (F J Radd), 543
Craddock, J M Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 858, work of, 858
Cragg, Dr B G Awarded a Locke Research Fellowship by the Royal Society, 595
  A Specific Response in the Hippocampus of the Rabbit to Olfactory Stimulation, 1697
  A Heat-Loss Mechanism involving the Habenular, Interpeduncular and Dorsal Tegmental Nuclei, 1724
Cragg, Prof J B Practical Animal Ecology, *review*, 1262
Cragg, Dr Thomas, and others Magnetic Field associated with a Great Solar Flare, 351
Craggs, J D (Prasad, A N, and) Ionization Phenomena in Gases (Recent Measurements on the Growth of Pre-breakdown Ionization Currents for Air), 1354
Craigmyle, M B L Cartilage Homografts in Papain-injected Rabbits, 1243
Cramer, Dr Friedrich Papierchromatographie, vierte Auflage, *review* by Dr R Consden, 1436
Cramp caused by Phenol Effect of Flavins on (Prof Kunio Yagi, Dr Hirofumi Yagi and Dr Ikuko Nagatsu), 1648
Crampton, Prof Charles F, and others Mechanism of Immunological Unresponsiveness, 873
Cranberg, Dr L Nuclear Forces and the Few-Nucleon Problem (Binding Energies and Elastic Scattering of Light Nuclei at Low Energies), 1114
Cranbrook, Earl of At the Conference of the Mammal Society of the British Isles (The Saliva of the Water Shrew), 29
Cranshaw, T E (Hillas, A M, and) A Comparison of the Charges of the Electron, Proton and Neutron, 892
Cranwell, Lucy M Fossil Pollen from Seymour Island, Antarctica, 1782
Craters on the Far Side of the Moon Absence of (David B Beard), 1631
Crawford, D V Availability of Plant Nutrients, 159
Crawford, Dr J D (Kennedy, Dr G C, and) An Antimineralocorticoid Action of some Saluretic Sulphonamides, 1492
Crawford, M Biological Problems arising from the Control of Pests and Diseases, 1101
Creation (Continual), of Matter The Steady-Rate Universe and the Deduction of (Prof V A Bailey), 537, (Prof G Bondi), 537
Creative Leadership in a State Service—a General Survey (Sir George Schuster), (Hospitals and the State—Hospital Organization and Administration under the National Health Service, Sixth and Final Research Report), 1087, 1201
Creed, E R Awarded a Nature Conservancy Research Studentship for postgraduate training in ecology (zoology), 156
Creed, R F S British Carnivores (Christmas Lecture at the Zoological Society of London), 1535
Creep Tests on Antarctic Glacier Ice (Malcolm Mellor), 717
Creeth, J M, and Nicol, L W Structure and Chemistry of Proteins (Urease), 1277
Creeth, J M, and Winzor, D J Structure and Chemistry of Proteins (Specificity of the Reaction of Iodine with the Sulphydryl Groups of Ovalbumin), 1277
Cremer, Herbert W, and Davies, Trefor (edited by) Chemical Engineering Practice, Vol 6, Fluid Systems II, *review* by Prof J M Coulson, 132
Crescenzi, V, and others Influence of Counterion Association on the Configurational Stability of Deoxyribonucleic Acid in Solution, 1482
Cresols and Toluidines Separation of the *Meta*- and *Para*-Isomers of the Xylenes, by Gas Solid Chromatography (M A Hughes, D White and Prof A L Roberts), 1796
Crespi, Henry L, and others Culture of Algae and other Micro-organisms in Deuterium Oxide, 729
  Chloroplast Pigments of Deuterated Green Algae, 730
Creutzberg, F Discrimination between Ebb and Flood Tide in Migrating Elvers (*Anguilla vulgaris* Turt) by means of Olfactory Perception, 1961
Crick, Dr Francis H C The Structure of Science, B A 8
Crisp, R S At the Second Australian Spectroscopy Conference (Vacuum Spectroscopic Technique—a Grazing Incidence, Photon-counting Grating Spectrometer), 1196
Cristae of the Elasmobranch *Raja clavata* A Functional Interpretation of the Electron-Microscopic Structure of the Sensory Hairs in the, in Terms of Directional Sensitivity (Prof O Lowenstein and J Wersall), 1807
Critical Importance of Transport and Communications (Sir Ewart Smith), B A 44
Crocker Sarcoma and Ehrlich Ascites Carcinoma Effect of Chlorpromazine on (Prof M Chorazy), 200
Croft, Eric D Oil Pollution of the Sea (Loss to the Tourist Trade presented by the Pollution of Beaches), 950
Croghan, Dr P C (Lockwood, Dr A P M, and) Composition of the Haemolymph of *Petrobius maritimus* Leach, 370
Croizat, Dr Léon Panbiogeography, or an Introductory Synthesis of Zoogeography, Phytogeography and Geology, Vol I, The New World, Vol 2a, The Old World, Vol 2b, The Old World (continuation), *review* by Prof Ronald Good, 924
Crone, W Reed (Klaus, Dr John D, and) Apparent Observation of Solar Corpuscular Clouds by Direct Continuous-Wave Reflexion, 965
Crook, A E Awarded the Douglas Hay Medal of the Institution of Mining Engineers, 1845
Crookall, J O, and others Current Trends of Strontium-90, Strontium-89 and Caesium-137 Levels in Milk, 89
Croom, Sheila, and others Two Anomalies in the Behaviour of the F2 Layer of the Ionosphere, 2003
Crop Protection The Principles and Practice of, *review* by F C Bawden, 1258
  The Scientific Principles of (Hubert Martin), fourth edition, *review* by F C Bawden, 1258
Crops (Agricultural and Horticultural) The Control of Pests and Diseases in (G L Hey and K Marshall), *review* by F C Bawden, 1258
Crops (Farm) Recognition of Diseases and Pests of (Ernst Gram, Prosper Bovien and Chr Stapel), *review* by F C Bawden, 1258
Crops (Glasshouse) Research Institute Annual Report for 1957, 161
Crops (Marine Standing) Proximate Analysis of (Dr T R Parsons and Dr J D H Strickland), 2038
Crosby, Dr D G (Vlitos, Dr A J, and) Isolation of Fatty Alcohols with Plant-Growth Promoting Activity from Maryland Mammoth Tobacco, 462
Cross, Dr J R Appointed superintendent of the Chemistry Laboratories in the University College of Swansea, 156
Cross, Dr L E Ferroelectricity, *review*, 6
Cross-Linking of Cellulose Acetate by Ionizing Radiation (Dr S H Pinner, T T Greenwood and D G Lloyd), 1303
Cross-Linking of Deoxyribonucleic Acid in Sperm Heads by Ionizing Radiations (Dr P Alexander and Dr K A Stacey), 958
Cross-Linking of Rubber Estimation of Chain Fracture and, by High-Energy Radiation (P Hayden), 1865
Crossed Polars A Special Case of the Superposition of Crystal Plates between, and its Bearing on the Microscopy of Cellulosic Fibres (Dr N H Hartshorne), 179
Crossing-over in *Drosophila melanogaster* Effect of Different Wild-type Isoalleles on (M M Green), 294
'Crossing-Paper Electrophoresis' Proof of the Formation of Enzyme-Substrate Complex by (Prof S Nakamura, K Takeo, I Sasaki and M Murata), 638
Crossley, P A (Butland, A N P, and) Science by the Upper Form (Some Scientific Aspects of the River Ouse), 597
Crouch, E A C, and others Atomic Weight of Silver, 358
Crow, Duncan Commonwealth Education—the United Kingdom Contribution, 592
Crowcroft, Peter North American Mammals, *review*, 1524
Crowder, L H (Radd, F J, and) Solid State Rheological Study of the Mechanism of Paraffin-Detergent Interactions in Aqueous Systems, 443
Crowder, L H, and others Relationship of *p*H to Aerobic Corrosion Fatigue Life of Steel, 2008
Crowe, G R Honorary degree of M A of the University of Cambridge conferred on, 1108
Crowe, P F, and others Gas Chromatographic Separation of Long-chain Fatty Acid Methyl Esters on Polyvinyl Acetate, 1710
Crown-Gall Tissue Extracts (Tomato) Occurrence of 3-Indolylacetic and 3-Indolecarboxylic Acids in (G Clarke, M H Dye and Prof R L Wain), 825
Crown Gall Tumour Induction A Possible Rôle of Indoleacetic Acid Oxidase in (Dr Jacques Lipetz), 1076
Croxatto, Prof H, and others Peptides with Oxytocic and Pressor Activity obtained from Acidified Rat Serum, 1496
Crude Vegetable Oils Chromatographic Identification of the Antilipaemic X Factor of the Unsaponifiable Fraction of (Prof M C Nath, A Saikia and B I Uppin), 1635
Cruickshank, Dr A J O Appointed reader in electrical engineering at Queen's College, Dundee, 684
Cruickshank, C N, and others Delayed Hypersensitivity ('Tuberculin-like' Reactions to Trichophytin in Guinea Pigs), 1030

Cruickshank, J G (Gresham, Dr G A, and) Protein Synthesis in Macrophages containing *Eimeria tenella*, 1153
Crushing and Grinding (Department of Scientific and Industrial Research), *review* by Prof S G Ward, 1177
Crussard, C, *et al* Atomic Mechanisms of Fracture (Value of the Electron Microscope in the study of Fractures), 325
Crustacea Syncarid, 1914
Crustaceans Hormone Control in (Dr David B Carlisle and Sir Francis Knowles), *review* by Prof J H Welsh, 1761
  Hormones in *review* by Prof J H Welsh, 1761
Cryogenic Engineering (Dr Russell B Scott), *review* by Dr G G Haselden, 1174
Cryptomonad Flagellates Chromoprotein Pigments of some (Photoreactive Pigments in Flagellates), (Dr Mary Belle Allen, Dr Ellsworth C Dougherty and Dr John J A McLaughlin), 1047
Cryptomonads Photosynthetically Active Accessory Pigments of (Photoreactive Pigments in Flagellates), (Dr F T Haxo and D C Fork), 1051
  Phycoerythrins and Phycocyanins of (Photoreactive Pigments of Flagellates), (Dr C ÓhEocha and M Raftery), 1049
Crystal Defects Influence of, on the Szilard-Chalmers Process in Solids (Dr A G Maddock and J I Vargas), 1931
Crystal Physics (British Association for the Advancement of Science, Section A (Mathematics and Physics), Discussion on), 596
Crystal Plates between Crossed Polars A Special Case of the Superposition of, and its Bearing on the Microscopy of Cellulosic Fibres (Dr N H Hartshorne), 179
Crystal Structure of L-Serine Phosphate (G H McCallum, Prof J Monteath Robertson and Dr G A Sim), 1863
Crystal Systems (Liquid), from Fibrillar Polysaccharides (R H Marchessault, F F Morehead and N M Walter), 632
Crystal (Single-) Electron Diffraction Pattern Structure of Precipitated Cadmium Sulphide as studied by (Dr Ryoitiro Sato), 2006
Crystalline Cytochrome b_5 (Dr Isaias Raw and Walter Colli), 1798
Crystalline Electric Field in Cobalt Acetate Tetrahydrate Temperature Variation of the Principal Magnetic Moments of Co^{++} Ions and the Asymmetry of the (Dr Bhagawati Charan Guha), 50
Crystalline *trans-trans* Methyl Linoleate Hydroperoxide Preparation of (A Banks, S Fazakerley, J N Keay and J G M Smith), 816
Crystalline Needles Appearance of, in Monkey Kidney Cell Cultures Infected with Poliomyelitis Virus and Incubated at 22-30° C (Dr Esther Tenenbaum), 1657
Crystalline Salt (A New), of Oxytocin (Dr Miklos Bodanszky and Prof Vincent du Vigneaud), 981, *erratum*, 1777
Crystalline Silica (Fused and) Structural Defects in (Dr W C Levengood), 1476
Crystalline State Visible Absorption Spectra of Copper-ethylene-diamine-*bis* (acetylacetone) in the (Animesh Chakravorty and Dr Sadhan Basu), 50
Crystallographic Studies of the Biuret Reaction (Dr H C Freeman, J E W L Smith and J C Taylor), 707
Crystallography (X-Ray) The Powder Method in (Prof Leonid V Azároff and Prof Martin J Buerger), *review* by Prof H Lipson, 1599
Crystals Ferroelectricity in (Dr Helen D Megaw), *review* by Dr L E Cross, 6
  Intermolecular Distances and Diamagnetic Anisotropy in, as Measures of the Polarity of Benzene and Borazole Substituents (Dame Kathleen Lonsdale), 1060
  Twinning of (International Mineralogical Association Symposium on), 1910
Crystals (Ice), grown in Hydrogen, Carbon Dioxide and Air at Reduced Pressure Habit of (A P van den Heuvel and Dr B J Mason), 519
Crystals (Mercuripapain) The Unit Cell of (J Drenth and J N Jansonius), 1718
Crystals (Polymer Single) Evidence for Distinct Sectors in (D C Bassett, Prof F C Frank and Dr A Keller), 810
Crystals (Zinc Single) Fatigue-Induced After-Effect in (A H Melaka and G B Dunn), 896
Csapo, Dr Arpad (Costa, Dr Luiz Macedo, and) Asymmetrical Delivery in Rabbits, 144
Ctenophore *Bolinopsis infundibulum* (O F Muller) Feeding of a (A K Nagabhushanam), 829
Cuba and the Isla de Pinos Variation in Lizards of the *Leiocephalus cubensis* Complex in (Albert Schwartz), 1107
Cubero, Dr Felisa Nuñez Awarded a Spanish Fellowship in Chemistry for 1959-60 by the Ramsay Memorial Fellowships Trustees, B A 16
Cubic Boron Nitride Transformation of a, to a Graphitic Form of Hexagonal Boron Bitride (H Judith Milledge, E Nave and F H Weller), 715
Culex fatigans Wied (1828) Induced Mutations of X-Ray Irradiations in (R Pal and B S Krishnamurthy), 658
Cullis, Dr C F Oxidation of Organic Compounds (Oxidation of Inorganic and Organic Compounds by Permanganate), 326
Cultivated Tea Top Growth of (Dr D N Barua), 1424
Cultivation of HeLa Cells Discarded Blood Bank Blood as a Source of Protein for (Billy R Blakey and Prof George E Gifford), 1158
Cultivation (*In vitro*), of Blood Cells of *Drosophila melanogaster* in a Synthetic Medium (Dr Masakatsu Horikawa and Dr Yukiaki Kuroda), 2017
Cultural Property, International Centre for the Study of the Preservation and Restoration of Inauguration of the, 504
  Appointment of Dr H J Plenderleith as first director, 504
Culture Cell and Organ (British Association for the Advancement of Science, Section I (Physiology and Biochemistry), Discussion on), 935
  Cell and Tissue (Dr John Paul), *review* by Dr I Leslie, 1009
  Production of Serum Albumin and of Globulins by Chick Mesenchymal Tissue and by HeLa Tumour Tissue in (Y Abdel-Samie, Prof E Broda, G Kellner and W Zischka), 361, *erratum*, 943
  X-Ray Damage and Recovery in Mammalian Cells in (M M Elkind and Harriet Sutton), 1293
Culture of Algae and other Micro-organisms in Deuterium Oxide (Henry L. Crespi, Sylvia M Archer and Joseph J Katz), 729
Culture of *Blatella germanica* under Aseptic Conditions A Simplified Method for the (R B Clayton), 1166
Culture of Cells, *review* by Dr I Leslie, 1009
Culture (Cell) Growth-Controlling Action of Human Serum in (Dr Kari Penttinen and Dr Erkki Saxen), 1570
Culture (Continuous-Flow), of the Filamentous Mould *Penicillium chrysogenum* and the Control of its Morphology (S J Pirt and D S Callow), 307
Culture (*In vitro*), of the Inflorescences, Flowers and Ovaries of an Apomict, *Aerva tomentosa* Forsk (Prem Murgai), 72
Culture (Indian) The Pre-historic Background of (Colonel D H Gordon), *review* by M C Burkitt, 131
Culture (Pure) of the Pathogenic Agent of Tyzzer's Disease of Mice (Dr K. Kanazawa and A Imai), 1810
Culture (Tissue) An Attenuated Strain of Canine Distemper Virus in (Prof Gunnar Rockborn), 822
  Transformations of Myxoma into Vaccinia or Ectromelia Virus in (Hidesaburô Hanafusa, Teruko Hanafusa and Juntarô Kamahora), 1152
Culture (Tsetse Fly Tissue) Development of *Trypanosoma vivax* to the Infective Stage in (Dr William Trager), B A 30
Culture Cells (Human Tissue) Cellular Uptake of Deoxyribonucleic Acid by (Dr Stanley M Gartler), 1505
Culture Medium Estimation of μgm Quantities of Iron in, using Bathophenanthroline (P A Seamer), 636
Cultured Human Tissues Sex Chromatin in (Dr Charles P Miles), 477
Cultures of Calf Kidney Cells Interferon produced by (Dr D A J Tyrrell), 452
Cultures (Agar and Soil) Translocation of Cobalt-60 and Caesium-137 by Fungi in (Dr Erna Grossbard and Dr D R Stranks), 310
Cultures (Dextran-producing), of *Streptococcus bovis* Formation of Leucrose in (R W Bailey and Prof E J Bourne) 904
Cultures (Monkey Kidney Cell), infected with Poliomyelitis Virus and Incubated at 22-30° C, Appearance of Crystalline Needles in (Dr Esther Tenenbaum), 1657
Cultures (Organ) of Total Mammary Glands of the Mouse (Dr F J A Prop), 379
Cultures (Roller Tube Tissue) Use of Transparent Cellular Film for (John A Sharp), 1508
Cultures (Plant Tissue) Oxidative and Phosphorylative Activities of Cytoplasmic Particles from (Taiki Tamaoki, Prof A C Hildebrandt, A J Riker, R H Burris and Bunji Hagihara), 1491
Cultures (Tumour-Cell), in Contact with Lysozyme Appearance of Granules in the Cytoplasm of (Dr Carlo Callerio), 202, *erratum*, 508
Cultures (Two), and the Scientific Revolution (Sir Charles Snow), 295
Cultures (The Two), and the Scientific Revolution (Dr W L Sumner), 411
Cummack, C H, and King, G A M Disturbance in the Ionospheric F-Region following the Johnston Island Nuclear Explosion, B A 32
Cumming, Dr Bruce G Extreme Sensitivity of Germination and Photoperiodic Reaction in the Genus *Chenopodium* (Tourn) L, 1044
Cummins, Dr C S, and Harris, Dr H Taxonomic Position of *Arthrobacter*, 831
Cundy, E K (Windle, W, and) Clay Minerals (Occurrence of Zinnwaldite in Cornwall), 780
Cupps, P T (edited by Cole, H H, and) Reproduction in Domestic Animals, Vol I, *review* by Dr S J Folley, 1091
Curare and Curare-like Agents (edited by D Bovet, F Bovet-Nitti and G B Marini-Bettelo), *review* by Dr Marthe Vogt, 1093
Curative Effect of Selenium upon the Incisor Teeth of Rats deficient in Vitamin E (Prof J T Irving), 645
Curien, Dr H Twinning of Crystals (Degree of Symmetry which a Twin Axis may possess), 1810
Curnow, R N Statistics of Extremes, *review*, 754
Curran, Dr S C Appointed director of the Royal College of Science and Technology, Glasgow, 152, work of, 152
Current (Counter-) Evidence of a South Equatorial, in the Pacific Ocean (Joseph L Reid, jun), 209
Current (Counter-) Distribution of Proteins in Aqueous Polymer Phase Systems (Per-Åke Albertsson and Ed Jacques Nyns), 1465, *erratum*, 1688
Current (Ionic) Effects of the Energy of Strong Pulses of, on Micro-organisms in Suspension (B S Gossling), 1881
Current Fluctuations in the Oxide Cathode (Margaret Chisholm and Dr. L Jacob), 1058
Current Literature Index Cancer (Excerpta Medica Foundation), 941
Current Research on Noise (Derwent M A Mercer), 414
Current-Saturation Plasma Heating by (K A George), 1791
Current Trends of Strontium-90, Strontium-89 and Caesium-137 Levels in Milk (W Anderson, L K Burton and J O Crookall), 89
Currents (Conduction), in Liquid *n*-Hexane under Microsecond Pulse Conditions (A Harry Sharbaugh and P Keith Watson), 2006
Curry, Dr A S, and others Absorption of Zinc Phosphide Particles, 642
Curry, James B, and others Macromolecular Components of *Chlorella pyrenoidosa*, 963
Curtis B, and others Phospholipid Phosphoric Esters in the Human Placenta, 1870
Curti., G W, and others The Inner Solar Corona during June 1959, 1308
Curves (Titration), of Soil Organic Matter (R S Beckwith), 745
Cushing, Dr D H (Lee, A J, and) International Council for the Exploration of the Sea—Special International Geophysical Year Meeting, 1180
Cushion, A A (Logan, Dr W P D, and) Morbidity Statistics from General Practice, Vol I, General (Studies on Medical and Population Subjects No 14), 154
Customs and Religion of the Ch'iang (D C Graham), B A 15
Cutaneous Melanoma in Killifish Hybrids Effect of Thiourcil and Thyroxine on Development and Growth of (Prof A Stolk), 562
Cuthbertson, Dr D P Rumination, *review*, 839
Cuticle of Insects Secretion of Wax through the (Dr M Locke), 1967
Cutler, D, and Powles, Dr J G Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Cutler, D (Powles, Dr J G, and) Proton Resonance Relaxation Times in Mobile Liquids, 1123
Cutrona, Prof Louis J Appointed head of the Willow Run Radar Laboratory in the University of Michigan, 26
Cutteridge, Dr O P D Modern Network Theory in Electrical Engineering (Application of a Particular Continued-Fraction Expansion to a range of Problems of Active and Passive Networks), 1692
Cutting, Windsor C, and others Phenazine Di-*N*-Oxide as a Carcinostatic Agent, 908
Cuttlefish Buoyancy of the (Dr E J Denton and Dr J B Gilpin-Brown), 1330

Cyanocarbon Organic Compounds Histochemical Use of the (Prof John F Lhotka), 1153
Cyathostoma lari, Blanchard 1849 (Nematoda, Strongyloidea) Life-Cycle of (Dr R T Pemberton), 1423
Cyclic Growth Pattern in *Neurospora* Genetic Control of a (Growth Patterns in *Neurospora*), (Dr D R Stadler), 170
Cyclostome *Pertromyzon planeri* Haemoglobin Pattern of the, during the Course of Development (M Adinolfi, G Chieffi and M Siniscalco), 1325
Cygnus-A Radio Source Red-Shift Absorption Spectrum of the (Dr R D Davies and Dr R C Jennison), 803
Cypriot Woman (Turkish-) A Haemoglobin with Unusual Alkaline-denaturation Properties in a (Dr J E O'N Gillespie, Dr J C White, M J Ellis, Dr G H Beaven, W B Gratzer, Dr E M Shooter and R M E Parkhouse), 1876
Cysteine Protection against Radiation Cataract Possible Mechanism of (A Pirie and L G Lajtha), 1125
Cysticercus bovis Infection of Cattle with, by the Injection of Onchospheres (G Foyd and M C Round), 1510
Cystine labelled with Sulphur-35 Measurement of the Rate of Growth of Wool using (A M Downes and A G Lyne), 1884
Cystine (Selenium and) An Effect of, on Lipide Peroxidation in Tissues Deficient in Vitamin E (Dr John G Bieri), 1148
Cystine-Cysteine, Glutathione and Total Free Sulphydryl Contents of, in Arsenic-resistant and Sensitive Strains of the Blue Tick, *Boophilus decoloratus* (Dr J S Harington), 1739
Cystine Reductase (Triphosphopyridine Nucleotide-linked) A Reduced, in the Clothes Moth, *Tineola bisselliella* (Humm), (R F Powning and H Irzykiewicz), 1230
Cytidine Triphosphate Positive Inotropic Activity of (Winifred G Nayler and Marian McCulloch), 67
Cytochemical Detection of Polyaldehyde Moieties in Sections and Smears Fluorescent Schiff-Type Reagents for (Prof Frederick H Kasten, Vivian Burton and Peggy Glover), 1797
Cytochemical Study of Mitochondrial Structure (Prof C H Chopra), 656
Cytochrome b_5 Crystalline (Dr Isaias Raw and Walter Colli), 1798
  Methaemoglobin Reduction through (Nicola Petragnani, Otilia C Nogueira and Dr Isaias Raw), 1651
Cytochrome Oxidase Activity in the Sea Urchin Egg An Inhibitor of (Rachele Maggio and Alberto Monroy), 68
Cytochrome System of *Streptomyces* (Dr D J Niederpruem and Dr D P Hackett), 1954
Cytodifferentiation (edited by Dorothea Rudnick), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Cytological Identification of Proliferating Donor Cells in Chick Embryos injected with Adult Chicken Blood (P M Biggs and L N Payne), 1594
Cytology (published in the Russian language by the Academy of Sciences of the U S S R), 410
Cytology International, *review* by Prof J Bronte Gatenby, 574
  International Review of (edited by Prof G H Bourne and Prof J F Danielli), Vol 7, *review* by Prof J Bronte Gatenby, 574
Cytology of the Genus *Sanguisorba* (Kai Larsen), 743
Cytoplasm of Tumour-Cell Cultures in Contact with Lysozyme Appearance of Granules in the (Dr Carlo Callerio), 202, *erratum*, 508
Cytoplasmic Inheritance (Prof D G Catcheside), 1012
Cytoplasmic Nucleopeptides in Guinea Pig Liver (P Szafranski, E Sulkowski and T Golaszewski), 1940
Cytoplasmic Particles from Plant Tissue Cultures Oxidative and Phosphorylative Activities of (Taiki Tamaoki, Prof A C Hildebrandt, A J Riker, R H Burris and Bunji Hagihara), 1491
Cytosine Derivatives Photoautomerization of, on Ultra-violet Irradiation (Shih Yi Wang), 184
Czechoslovak Academy of Sciences Monographs and Source Material, Chemical Section, Vapour–Liquid Equilibrium (Eduard Hala, Jiří Pick, Vojtech Fried and Otakar Vilím), translated by G Standart, *review* by Dr R Sargent, 837

D REGION of the Ionosphere (B Bjelland, O Holt, B Landmark and F Lied), 973
Da Re, P , and others N-Substituted 7-Methoxy-8-Aminomethylchromones and Flavones—New Brain-Stem Stimulants, 362
Dadswell, Dr H E , and others Transport of Driftwood from South America to Tasmania and Macquarie Island, 203
Dagenais, Yves, and others Increased Circulating Insulin-like Activity in Obese-Hyperglycaemic Mice, 61
Dagger Nematode (*Xiphinema* sp) Role of a, in Outbreaks of Plant Diseases caused by Arabis Mosaic Virus (Dr B D Harrison and Dr C H Cadman), 1624
Dagger Nematodes associated with a Clover Sickness (F C Peacock) 123
'Dagmar' Microfilm Reader Microcard Adapter for (Trew Microfilming, Ltd), 941
Dagva, E The Mongolian Wild Horse, *Equus przewalskii*, 1024
Dahl, E Origin and Dispersal of Flowering Plants (Amphi-Atlantic Arctic-Alpine Plants), 1200
Daily Range of the Geomagnetic Vertical Intensity around the Magnetic Equator Possible Asymmetry in the (Dr C A Onwumechilli), 51
Dainton, A D , and others Coal Science (Carbonization—Effect of Macerals on Volume Changes in Briquettes during Carbonization), 413
Dairying, National Institute for Research in Annual Report for 1958, 770
  Grant of 89,348 dollars from the Population Council, Inc , New York, in support of researches on cervical mucus, with particular reference to the control of fertility, 1362
Dakin, T W , and Berg, Daniel Luminous Spots on Electrodes in Insulating Oil Gaps, 120
Dallimore, William *Obituary* by Dr F N Howes, 1684
Dalton, F L (Acres, G J K , and) A Capacitance Method for following Vinyl Polymerizations initiated by γ-Rays, 335
Dalton, R G (Fisher, E W , and) Cardiac Output in Horses, 2020
Daly Prof I de Burgh Flow Properties of Biological Systems, 1540
Damage (Recoil) Annealing of, by Ultra-Violet Light (R F C Claridge and Dr A G Maddock) 1932
Damage (Substrate), in Film Thickness Measurement by Beam Interferometry (Prof G David Scott), 354
Damage (X-Ray), and Recovery in Mammalian Cells in Culture (M M Elkind and Harriet Sutton), 1293
Damaged Endothelial Cells Some Properties of (Dr J R O'Brien), 1580
Dana Expeditions The Carlsberg Foundation's Oceanographical Expedition round the World 1928-30, and previous , *Dana* Report No 46, The Hydromedusae of the Atlantic Ocean and adjacent Waters (P L Kramp), *review* by J H Fraser, 300
Daniel, Dr V Dielectrics, *review*, 1175
Danielli, Prof J F (edited by Prof G H Bourne and) International Review of Cytology, Vol 7, *review* by Prof J Bronte Gatenby, 574
Danish Atomic Energy Commission Report for 1957-58, 517
Dapples, Prof E C Basic Geology for Science and Engineering, *review* by Dr J C M Taylor, 1175
Darkness (White and Colored Lights and) Behavior of Reactions of the Pacific Sardine, *Sardinops caerulea* (Girard), under the Influence of (Dr A S Loukashkin and Dr N Grant), 865
Darling, Prof A I Die gesunden und erkrankten Zahngewebe des Menschen und der Wirbeltiere im Polarisationsmikroscop, *review*, 218
Darling, Dr F Fraser Animal Behaviour, *review*, 302
Darling R C Maxwell (Pearson, E O , assisted by) The Insect Pests of Cotton in Tropical Africa, *review* by Dr W E China, 1011
Darwin Another Debt to, *review* by Prof T G Tutin, 129
  The Young, and the 'Origin of Species' (Prof C F A Pantin), 1533
Darwin and the Darwinian Revolution (Dr Gertrude Himmelfarb), *review* by Sir Gavin de Beer, 385
Darwin without Modern Science, *review* by Sir Gavin de Beer, 385
Darwin Centenary (*Notes and Records* of the Royal Society of London, Vol 14, No 1, devoted to the), 1776
Darwin's Illness (Prof S Adler), 1102
Darwinian Revolution · Darwin and the (Dr Gertrude Himmelfarb), *review* by Sir Gavin de Beer, 385
Data Biological Laboratory (Dr L J Hale), *review* by Prof R C McLean, 577
  Loss of Information brought about by Loss of (S C Pearce), 1826
  Meteorological, 942
Data on Research and Development Reviews of, No 13, Research and Development and Economic Growth (Dr A T Waterman), (United States National Science Foundation), 591
  Reviews of, No 14 Funds for Research and Development Performance in American Industry (United States National Science Foundation), 1022
  Reviews of, No 15, Grants for Private Philanthropic Foundations during 1957 (United States National Science Foundation), 1272
Data (Mutual Solubility) Estimation of the Interchange Energy for Binary Systems from (Kiyoharu Ishida), 814
Data (Tabular Comparative), for the Low- and High-Temperature Strains of *Chlorella* (Dr Constantine Sorokin), 613
Dating Radiocarbon (British Association for the Advancement of Science, Sections A (Mathematics and Physics) and H (Anthropology), Discussion on), 672
  Radiocarbon (*American Journal of Science*, Radiocarbon Supplement, Vol 1), 1686
Dating of Australian History (D J Mulvaney), 918
Dating of the Dead Sea Scrolls A New Approach to the (Prof D Burton, J B Poole and Dr R Reed), 533
Dating (Radiocarbon), of the Piltdown Skull and Jaw (Prof H de Vries and Dr K P Oakley), 224
Dating (Radiocarbon), of Prehistoric Wooden Trackways (Dr H Godwin and Dr E H Willis), 490
Datta, S P Title of reader in biochemistry in the University of London (at University College) conferred on, 1273
Davenport Prof H Some Recent Progress in the Analytic Theory of Numbers (Presidential Address to the London Mathematical Society), 1533
Davenport, Dr H E Relationship between Photophosphorylation and the Hill Reaction, 524
Davey, J T *Obituary* by Dr T H C Taylor, 1104
Davey, Prof T Biological Problems arising from the Control of Pests and Diseases (Control of Human Diseases in Tropical Areas), 1101
David, D J At the Second Australian Spectroscopy Conference (Chemical Interferences encountered in Applying Atomic Absorption to the Analysis of Plant Material and Soil Extracts), 1197
Davidson, Prof C F Suggestions to Authors of the Reports of the United States Geological Survey, *review*, 390
  Systematic Mineralogy of Uranium and Thorium, *review*, 576
  Mineralogy and Geology of Radioactive Raw Materials, *review*, 1262
  The Geological Time-Scale, 1310, 1473
Davidson, Eugene A Periodate Technique for the Identification of Sugar Phosphates, 1395
Davies, Dr C N Heating and Ventilation—British Occupational Hygiene Society Conference, 1987
Davies, Prof C W Principles of Electrolysis, *review* by Dr V Gold, 1902
Davies, D E , and others Ionization Phenomena in Gases (State of the Cathode on Growth Times and Sparking Potentials in Hydrogen), 1354 , (Influence of Gas Purity, Tube Geometry and Method of Calculation on the Determination of Ionization Coefficients in Hydrogen and the Inert Gases), 1354
Davies, D E N , and others Awarded the Brabazon Premium of the British Institution of Radio Engineers, 857
Davies, D I Appointed to a lectureship in the Department of Organic Chemistry in the University of Leeds, 1108
Davies, D K , and Llewellyn-Jones, F Ionization Phenomena in Gases (Influence of Collisions of the Second Kind between Excited and Neutral Molecules, on Secondary Ionization in Hydrogen), 1354
Davies, Dr D R Title of reader in applied mathematics in the University of Sheffield conferred on, 684
Davies, Dr D Roy, and Wall, E T Separation of Gamma-Irradiation of Two Elements at the Vby Locus in *Trifolium repens*, 1957
Davies, Prof G M Appointed to the chair of agriculture in the University of Malaya in Kuala Lumpur, 306 , work of, 306

Davies, H R J Effects of the Water Hyacinth (*Eichornia crassipes*) in the Nile Valley, 1085
Davies, Dr J Griffiths Appointed first chief of the new Division of Tropical Pastures of the Australian Commonwealth Scientific and Industrial Research Organization, 93
Davies, Dr J G, and Lovell, Prof A C B Observations of the Russian Moon Rocket *Lunik II*, 501
Davies, J H, and Malkin, Dr T Synthesis of 1-Glyceryl-2-*myo*-inositol Phosphate (Syntehsis and Properties of 1-Glyceryl-2-*myo*-inositol Phosphate), 789
Davies, J W (Harris, G, and) Nucleotide–Peptide Compounds of *Saccharomyces cerevisiae*, 788
Davies, M Bryn (Jeffares, Prof A Norman, and) The Scientific Background, *review* by Dr W L Sumner, 5
Davies, Dr M E Appointed lecturer in botany at the University of Birmingham, 1026, 1362
Davies, P L (Caddock, B D, and) Use of Tritium to Study the Solubility of Water in Hydrocarbons, 2011
Davies, P W Appointed assistant lecturer in metallurgy at the University College of Swansea, 156
Davies, Dr R D, and Jennison, Dr R C Red-Shift Absorption Spectrum of the Cygnus-*A* Radio Source, 803
Davies, Prof R O Retirement from the chair of agricultural chemistry in the University College, Aberystwyth, 317, work of, 317
Davies, Prof S J Biomechanics, 512
Davies, Trefor (edited by Herbert W Cremer and) Chemical Engineering Practice, Vol 6, Fluid Systems II, *review* by Prof J M Coulson, 132
Davies, Dr W Influence of the Thomson Effect on the θ-φ Relationship for a Constrictive Resistance in Thermal Equilibrium, 975
Davies, Dr W Grassland Management, *review*, 1675
Davis, Prof Edward L Production of Seedless Hops by Interspecific Pollination, 1336
Davis, H G, and others Coal Science (Chemical Reactions of Coal—Phenolic Hydroxyl in Vitrains), 412
Davis, Dr J G Elected chairman of the Association of Consulting Scientists, 508, 1777
Davis, R University of Oxford Second Tanganyika Expedition, 1543
Davison, A L, and others Teichoic Acids from Bacterial Walls—Composition of Teichoic Acids from a Number of Bacterial Walls, 247
Davy Medal for 1959 of the Royal Society awarded to Prof R B Woodward, 1189, 1834, work of, 1834
Dawe, Clyde J, and others Antibody Status of Mice and Response of their Litters to Parotid Tumour Virus (Polyoma Virus), 1420
Dawes, Dr Ben Penetration of the Liver-fluke, *Fasciola hepatica*, into the Snail, *Limnaea truncatula*, 1334
Dawson, Elliot W *Obituary* of Prof E Percival, 403
Dawson, Dr J K Heavier Elements, *review*, 922
Day, A C Appointed to a research fellowship in chemistry in the University of Glasgow, 1915
Day, D J Heating and Ventilation (Engineering Aspects of Cabin Air-conditioning in Military Aircraft), 1987
Day, W R Pathogenic Factors in the Rooting Space and the Development of Even-Aged Plantations (Presidential Address to Section K* (Forestry) of the British Association for the Advancement of Science), B A 46
Days (Disturbed) Geomagnetic Activity at Halley Bay on (J MacDowall), 1543
DDT Pyrethrum Resistance conferred by Resistance to, in the Blue Tick (G B Whitehead), 378
De, P K, and others A New Nitrogen-fixing Bacterium, 1743
de Beer, Sir Gavin Darwin without Modern Science, *review*, 385
  Additions to the British Museum (Natural History), 1682
de Belatini, P C M Inadequacy of Scatter Mechanisms in Tropospheric Radio Propagation, 1558
De Boer, F E (Youngdahl, C A, and) Analysis for Magnesium in High-Purity Aluminium, 54
de Castro, Nylceo Marques, and Sasso, Wilson da Silva Sex Chromatin ('Chromoleme') in the Purkinje Nerve Cells of some Mammals, 293
de Duve, C Enzymes (Localization of Enzymes within the Cell), 687
de Feiter, L D, and others Association of Radio Outbursts with Solar Flares, 805
de Franciscis, Dr Pietro, and Landauer, Prof Walter Combined Effects of Cortisone and Insulin on Developing Chicken Embryos, 101
De Gregorio, P, and others Distribution of Nucleic Acids among Different Stable *L* Forms of *Proteus P* 18, 566
de Groot, A P Dietary Protein and Serum Cholesterol in Rats, 903
de Havilland Aircraft Co, Ltd To be presented with the Elmer A Sperry Award for outstanding achievement in the field of transportation, 595
de Jongh, Dr D K, and Linnewiel, H A A Peripheral Effect of the Bromide Ion on the Contraction of Striated Muscle, 1240
de Kock, Dr L L, and Symmons, Dr S A Ligament in the Dorsal Aorta of certain Fishes, 194
de Layrisse, Dr Zulay (Layrisse, Dr Miguel, and) Frequency of the New Blood Group Antigen Js^a among South American Indians, 640
de Lint, P J A L Complex Reaction in *Hyoscyamus niger* upon Night Interruption with Red Light, 731
De Maeyer, L Fast Chemical Reactions in Solution (Relaxation Methods), 1453
De Marco, C, and others Degradation of Thiotaurine by Ionizing Radiations, B A 61
de Margerie, Helene, and others Production of Colicine by Single Bacteria, 337
de Mayo, P Mon- and Sesquiterpenoids (The Chemistry of Natural Products, Vol 2), *review* by Prof A J Birch, 754
  The Higher Terpenoids (The Chemistry of Natural Products, Vol 3), *review* by Prof A J Birch, 754
de Mende, Serge (Audubert, René, and) The Principles of Electrophoresis (translated by A J Pomerans), *review* by Dr R Consden, 84
De Morgan Medal of the London Mathematical Society presented to Sir William Hodge, 1533
de Muralt, Prof A At the 139th Annual Meeting of the Swiss Society for Natural Sciences (The First Seven Years of the Swiss National Fund for Scientific Research), 1454
de Oliveira, Dr José Osorio (introducao de) Flagrantes da Vida na Lunda (Companhia de Diamantes de Angola, Museu fo Dundo, Publicacoes Culturais No 37), 236
de Rose, F Elected president of the Council of the European Organization for Nuclear Research (CERN), 1844
De Somer, P, and others Infectivity of Polio Virus Ribonucleic Acid for Embryonated Eggs and Unsusceptible Cell Lines, 652
de Vattimo, Ida, and others Phylogeny of the Genus *Aniba* Aubl—a Comparative Morphological and Chemical Observation, 1589
de Vries, Prof H, and Oakley, Dr K P Radiocarbon Dating of the Piltdown Skull and Jaw, 224
De Witt, Dr C W, and Rowe, J A *N*,O-Diacetylneuraminic Acid and *N*-Acetylneuraminic Acid in *Escherichia coli*, 381
de la Mare, Dr P B D Appointed to the University of London chair of chemistry at Bedford College, 1613, 1913, work of, 1913
de la Mare, Dr P B D, and Ridd, J H Aromatic Substitution—Nitration and Halogenation, *review* by Prof M J S Dewar, 925
Deacon, Dr G E R International Oceanographic Congress, 1605
Dead Sea Scrolls A New Approach to the Dating of the (Prof D Burton, J B Poole and Dr R Reed), 533
Deaminases of Adenylic Acid and Adenosine in Rat Kidney (Dr M Zydowo), 1641
De-amination (Spontaneous), of Amino-Acid Phosphates under Physiological Conditions (Dr Mella Paecht and Prof A Katchalsky), 1489
Debay, C R, and others Activation and Inhibition of the Arylesterase of Human Serum, 430
Debris (Nuclear Weapons) Fractionation Phenomena in (K Edvarson, Kerstin Low and J Sisefsky), 1771
Debt to Darwin Another, *review* by Prof T G Tutin, 129
Debye, P Macromolecules (Estimating Molecular Interactions from Measurements of Light Scattering), 1689
Decarboxylase (Histidine) Pyridoxal Phosphate, a Coenzyme for (S Ono and Prof P Hagen), 1143
Decarboxylation (Enzymatic), of Stipitatonic and Puberulonic Acids Tropolone Biosynthesis—the (Prof Ronald Bentley and Clara P Thiessen), 552
Decarboxylation (Thermal), of some Keto-Acid Hydrazones (Ambrose M Tokushige and Prof Elton S Cook), 267
Decay of a Tau-Meson Underground (A M Short), 893
Decerebrate Sheep Responses to Localized Distension of the Oesophagus in (Prof A F Sellers and Dr D A Titchen), 645
Deciduoma of the Rat Carbonic Anhydrase in the (Dr T H Johnson, Dr C Lutwak-Mann and Prof M C Shelesnyak), 961
Deciduous Woody Plants treated in Autumn with Gibberellic Acid Extended Dormancy of (Dr P W Brian, J H P Petty and P T Richmond), 69
Decomposition (Thermal), of Irradiated Lead Oxalate (P J Herley and E G Prout), 445
Decrease in Acid Strength of Propionate Side-Chains of Haematin on Reduction to Haem (Dr J E O'Hagan), 1808
Decrease in Radiosensitivity of the Intact Mouse Spleen produced by Hypoxia (Dr L Weiss), 1156
Decrease (Forbush) Evidence for Cosmic Ray Energy Spectrum Changes during a (K W Ogilvie and M M Winn), 888
Deduction of Continual Creation of Matter The Steady-Rate Universe and the (Prof V A Bailey), 537, (Prof G Bondi), 537
Deeley, E M High Speed Computing *review*, 1832
De-embryonated Chick Blastoderm 8-Azaguanine Inhibition of Haemoglobin Synthesis in (B R A O'Brien), 376
Deep-Sea Ash (Worzel) Origin of the (Edward Anders and Dr D Nelson Limber), 44
Deep Sea Fauna Palaeotemperatures and the Origin of the, 1025
Deep-Sea Jellyfish A Viviparous (Dr F S Russell), 1527
Dees, Dr Bowen C Appointed assistant director for scientific personnel and education at the United States National Science Foundation, 1686, work of, 1686
Defects (Crystal) Influence of, on the Szilard-Chalmers Process in Solids (Dr A G Maddock and J I Vargas), 1931
Defects (Point), in Metals and Alloys Vacancies and other—a Symposium organized by the Institute of Metals, 1957 (Monograph and Report Series, No 23), *review* by Dr F C Thompson, 1765
Defects (Structural), in Fused and Crystalline Silica (Dr W C Levengood), 1476
Defence of Free Learning (Lord Beveridge), *review* by R Brightman, 576
Defence, Ministry of Retirement of Sir Frederick Brundrett as scientific adviser and chairman of the Defence Research Policy Committee, 1105
  Appointment of Sir Solly Zuckerman as scientific adviser, 1105
Defence Research Board (Canadian) Formation of an Associate Committee on Space Research by the National Research Council of Canada, jointly with the, 24
Defence Standards Laboratories (Australian) Technical Memorandum 2, The Intensity of Infra-red Absorption Bands—a Bibliography (compiled by Dr R G Gillis), 682
  Annual Report for 1956-57, 782
Defendi, Dr V The Structure of Science (Virus-Host Cell Relationships of Two Tumour-inducing Viruses), B A 9
Defendi, Dr V, and Koprowski, Dr H Influence of Adult Lymphoid Tissues on Polyoma-induced Tumours, 1579
Defensive Acid-Secretion in some Marine Gastropods (Dr T E Thompson), 1162
Deficiency (Magnesium), in Lambs on a Diet containing Roughage Experimental Production of (Dr D M McAleese and Dr R M Forbes), 2025
Deficiency (Pantothenic Acid), and Ubiquinone Levels in Rat Liver Mitochondria (A S Aiyar, G A Sulebele, D V Rege and A Sreenivasan), 1867
Deficiency (Pyridoxine) Rat Brain Glutathione and (M J Ashwood-Smith and A D Smith), 2028
Deformation (Dynamic and Static), of Armco Iron (H P Tardif and P Chollet), 1917
Degradation of Thiotaurine by Ionizing Radiations (D Cavallini, B Mondovi, B Giovanella and C De Marco), B A 61
Degradation (Microbial), of Rutin (Dr S Hattori and I Noguchi) 1145
Dehydrated and Fasted Mice Subcutaneous Absorption of Urethane in (Eigill Hvidberg and Jens Schou), 646
Dehydroascorbic Acid and Alloxan Inhibition of Liver Hexokinase by (Dr S K Bhattacharya), 1638

Dehydrogenase (Glucose-6-phosphate) Characteristics of, from Normal and Primaquine-sensitive Erythrocytes (Glucose-6-phosphate Dehydrogenase and Human Erythrocytes), (Dr Henry N Kirkman), 1291

Dehydrogenase (Glucose-6-phosphate), and Human Erythrocytes—Characteristics of Glucose-6-phosphate Dehydrogenase from Normal and Primaquine-sensitive Erythrocytes (Dr Henry N Kirkman), 1291 , Mechanism of Inactivation of Glucose-6-phosphate Dehydrogenase in Human Erythrocytes (Dr Paul E Carson, Stanley L Schrier and Robert W Kellermeyer), 1292

  Mechanism of Inactivation of Glucose-6-phosphate Dehydrogenase in Human Erythrocytes, (Dr Paul E Carson, Stanley L Schrier and Robert W Kellermeyer), 1292

Dehydrogenase (Glutamic), of Mung Bean Mitochondria (Dr D H Bone), 990

Dehydrogenase (Glyceraldehyde-3-phosphate) Rôle of the Co-enzyme in the Stabilization of (P Elodi and G Szabolcsi), 56

Dehydrogenases (Apo- and Co-) Interaction of Streptomycin and Dihydrostreptomycin with (Prof M Michalska), 987

Dekock, Dr P C (Morrison, R I, and) Glyceric Acid in Broad Bean (*Vicia faba* L), 819

Delafresnaye, J F (edited by J F Jonxis and) Abnormal Haemoglobins—a Symposium organized by the Council for International Organizations of Medical Sciences, *review* by Dr J A M Agar, 840

Delany, M J (Copland, W O, and) At the Conference of the Mammal Society of the British Isles (Small Mammals of South Rona), 30

Delavarenne, S, and others Coal Science (Chemical Reactions of Coal—Acetylation), 412

Delayed Hypersensitivity (British Society for Immunology Symposium on) 1029

Delinquency Preventing Juvenile, 1203

Delivery (Asymmetric), in Rabbits (Dr Luiz Macedo Costa and Dr Arpad Csapo), 144

Dellacha, J M, and others Histological Localization of Fluorescent Thyroid-stimulating Hormone in Rat Tissues, 1733

Delorme, E J, and others An Improved Technique for Intravenous Injection of Newborn Rats and Mice, 1952

γ-Irradiated Polymethyl Methacrylate and Polymethacrylic Acid Electron Paramagnetic Resonance at 4 2°K of (Dr Derick W Ovenall), 181

Demain, Dr A L (Hendlin, Dr D, and) An Absolute Requirement for 'Iron Transport Factors' by *Microbacterium lacticum* 8181, 1894

Demand (Growing), for Water First Report of the Subcommittee on the (Central Advisory Water Committee), B A 18

Demand (Water Supply and), in Great Britain (Prof W G V Balchin), B A 18

Demerec, M Biological Effects of Low Doses of Ionizing Radiations (Use of three Biochemical Mutations), 1113

Demineralized Water Units Non-Cartridge Types, 25

'Deminrolit' Plants for Distilled Water (Permutit Co, Ltd), 25

Democracy (Modern) The Development of Public Services in a, 1087

  General Education in a, 1171

Demographic Yearbook 1958 (Special Topic, Marriage and Divorce Statistics), (United Nations), *review*, 1525

Demonstration (Experimental), of an Internal Rhythm of Reproduction in a Trans-Equatorial Migrant (the Short-tailed Shearwater *Puffinus tenuirostris*), (Dr A J Marshall and Dr D L Serventy) 1704

Dempster, Dr J J B Mathematics in Secondary Modern Schools (Contact between Teachers in Secondary Modern Schools and Lecturers in Technical Colleges), 33

Denatured with Tannin Effect of Ultra-sound on the Protein of Human Serum (Dr Wizold Mizgalski and Irena Zygmunt), 1486

Denatured Deoxyribonucleates (Native and) Aggregation of an Acridine Dye on (Dr D F Bradley and Dr G Felsenfeld), 1920

Denervated Adrenal Medulla Effects of Reserpine on Secretion from the (L Stjarne and S Schapiro) 2023

Denneny, Joan M (Winder, Frank and) Effect of Iron and Zinc on Nucleic Acid and Protein Synthesis in *Mycobacterium smegmatis*, 742

Dennis, R W G Maladies of Hevea in Malaya, *review*, 1976

Dennison, David S Gallic Acid in *Phycomyces* Sporangiophores, 2036

Dense Laminar Structure found in Conjunction with Cell Membranes in the Anterior Pituitary Gland (Barbara G Barnes), 651

Density of the Upper Atmosphere from Analysis of Satellite Orbits—Further Results (D G King-Hele), 1267

Density (Air), in the Upper Atmosphere from Satellite Orbit Observations (Dr G V Groves), 178

Density-Height Profiles (Electron) Conversion of Ionospheric Virtual Height-Frequency Curves to (Dr J O Thomas and M D Vickers), (Radio Research Board, Special Report No 28), 1024

Density Variations (Upper Atmosphere), due to Hydromagnetic Heating (Dr A J Dessler), 261

Dental Pain Association between Colour of the Iris of the Eye and Reaction to (Dr Philip R N Sutton), 122

Denton, Dr E J, and Gilpin-Brown, Dr J B Buoyancy of the Cuttlefish, 1330

Denyer, G E Science and Philosophy 1193

Deoxyribo- or Ribo-Nucleic Acids Comparative Effects of Heat on Chromatography and Ultra-violet Absorption of (Dr Saul Kit), 36

Deoxyribonuclease I A Biological Action of, on the Growth of *Euglena gracilis* (Dr Rudolf K Zahn), 1324

Deoxyribonucleate and Magnesium Ions Determination of the Interaction of, by means of a Metal Ion Indicator (Joseph Shack and Barbara S Bynum), 635

Deoxyribonucleates (Native and Denatured) Aggregation of an Acridine Dye on (Dr D F Bradley and Dr G Felsenfeld), 1920

Deoxyribonucleic Acid Cells which Synthesize, in Guinea Pig Bone Marrow during Recovery from Whole-body γ-Irradiation (P F Harris and J H Kugler), 1883

  Cellular Uptake of, by Human Tissue Culture Cells (Dr Stanley M Gartler), 1505

  Dielectric Studies on (H G Jerrard and B A W Simmons), 1715

  Immunization with Biologically Active Fractions of, and Subsequent Specific Infection of Mice (Dr M Kohoutova), 1965

  Possible Simplified Structure of (Dr M H Silk and A O Hawtrey), 1484

  Synthesis of, in Adult *Drosophila* (Per Oftedal), 1961

Deoxyribonucleic Acid in Eggs of the Polypodiaceous Ferns (Dr P R Bell), 1664

Deoxyribonucleic Acid from Rat Sarcoma and Hepatoma An Attempt to produce Malignant Change with (Dr J G Bearn), 824

Deoxyribonucleic Acid in the Seminal Vesicle Influence of Sexual Stimulation on the Metabolic Activity of (Dr S R Pelc), 1414

Deoxyribonucleic Acid in Solution Influence of Counterion Association on the Configurational Stability of (F Ascoli, C Botre, V Crescenzi, A Mele and Prof A M Liquori), 1482

Deoxyribonucleic Acid in Sperm Heads Cross-Linking of, by Ionizing Radiations (Dr P Alexander and Dr K A Stacey), 958

Deoxyribonucleic Acid (Highly Polymerized Spleen), labelled with Phosphorus-32 Injected Intraperitoneally into Rats Fate of the (Tamara A Hudnik-Plevnik, Vladimir R Glišin and Marta M Simic), 1818

Deoxyribonucleic Acid (Modified) Unimpaired Mitosis in Cells with (Rolla B Hill, jur , Klaus G Bensch and Donald W King), 1429

Deoxyribonucleic Acid Content (Aneuploid), of Human Carcinomas (H F Stich and H E Emson), 290

Deoxyribonucleic Acid Content (Nuclear), and Endopolyploidy in the Meristem of Onion Roots (D Srinivasachar), B A 80

Deoxyribonucleic Acid Formation in Multiplying HeLa Cells (C L Smith, A A Newton and P Wildy), 107

Deoxyribonucleic Acid Synthesis in *Escherichia coli* 15T Influence of Unbalanced Growth on Subsequent X-Ray Induced Inhibition of (Daniel Billen), 174

Depletion of Adrenal Catechol Amines induced by Reserpine Abolition by Chlorpromazine of the Inhibiting Effect of Iproniazid on the (F Camanni, Dr G M Molinatti and M Olivetti), B A 65

Depletion (Protein) Effect of, on the Distribution of Protein Synthesis (Dr John Waterlow), 1875

Deposited Fall-Out Gamma-Radiation from (D H Peirson and L Salmon), 1678

Deposition of Trace Elements in Basic Magma (R J P Williams), 44

Depot Fats of Ruminants and Non-Ruminants Trans-Unsaturated Acids in the (L Hartman and Dr F B Shorland), 2024

Depression (University of Cambridge Post-Graduate Medical School Symposium on), 322

Depression (Great) Lancashire Livestock Farming in the (T W Fletcher), 1916

Depth of Isostatic Compensation and Mohorovočic Discontinuity, etc , in Continental and Oceanic Areas (J N Nanda), 629

Derbyshire The Place-Names of (Kenneth Cameron), Part 1, Introduction, River-Names, etc , High Peak Hundred , Part 2, Scarsdale Hundred, Wirksworth Hundred, Morleyston and Litchurch Hundred , Part 3, Appletree Hundred, Repton and Gresley Hundred, Analyses, Index, *review* by I S Maxwell, 1767

Deresiewicz, Prof H Elements of Engineering Statics, *review* by T M Charlton, 1674

Derivatives Mothicidal Rhodanine (Frederick J Allan, G Graham Allan and Claud M'F M'Neil), 1637

Derivatives of 2-Aminofluorene Possible Relation between Carcinogenicity and Ease of Hydrolysis *in vitro* of (Prof Mary F Argus and Francis E Ray), 2018

Derivatives containing Nitro Groups Quantitative Paper Chromatography based on the Sub-Micro Titration of (L Blom and J Caris), 1313

Derivatives (Anionic), of Synthetic Polyglucoses Reduction of Toxicity of Cationic Macromolecules by Complexing with (P T Mora, B G Young and M J Shear), 431

Derivatives (Cytosine) Photoautomerization of, on Ultra-violet Irradiation (Shih Yi Wang), 184

Derivatives (Soluble) Extraction of the Total Protein of Wheaten Flour in the Form of (E E McDermott and Dr J Pace), 546

Dermatitis 'Parsnip' (B J Youngman), 594

Dermatophytes Effect of Steroids and related Compounds on the Growth of (Dr F W Chattaway, J D Townsley and A J E Barton), 1731

Dermikhanov, —, and others Ionization Phenomena in Gases (The Interaction of a Beam of Charged Particles with a Plasma), 1356

Desai, Dr V M, and Thirumalachar, Dr M J Floral Malformation in *Panicum antidotale* caused by a Species of *Eriophyes*, 1586

Design of Hydrological Networks (Max A Kohler), (World Meteorological Organization, Technical Note No 25), 96 *erratum*, 684

Design of Physics Research Laboratories—a Symposium of the London and Home Counties Branch of the Institute of Physics (London, 1957), *review* by S Weintroub, 925

Design (Engineering Materials and) Conference on New, 1362

Desnuelle, P Enzymes (Chemical Structure of Proteins and Mechanism of Action of Proteolytic Enzymes), 687

Desorption (Salt), from Halloysite (Prof G W Thomas), 1746

Desowitz, Dr Robert S Paper Electrophoresis of Trypanosomal Extracts, 986

Dessler, Dr A J Upper Atmosphere Density Variations due to Hydromagnetic Heating, 261

Destruction of Carotenoids in Isolated Chloroplasts (J Friend and T O M Nakayama), B A 66

Desty, D H Gas Chromatography, 327

Desty, D H (read by, for Dr J Janak) Gas Chromatography (Application of Gas Chromatography to the Identification of Structure of Involatile Substances by Pyrolysis), 1199

Detail Vision (Spatial) Measurements of Temporal Adaptation to (A J Seyler and Z L Budrikis), 1215

Détecteurs de Particules (Compteurs et Scintillateurs), Mécanisme et Réalisation (Daniel Blanc), *review* by Dr E P Paul, 1977

Detecting Virulent Clones of *Fusarium oxysporum* f *cubense* A Rapid and Simple Pathogenicity Test for, using Seedlings of *Musa balbisiana* (Dr R H Stover), 1591

Detection of 2 4-Dinitrophenyl Amino-Acids on Paper Chromatograms (Dr A H Maddy), 1397

Detection of Thyroid Antibodies using Bentonite Particles (Dr J A M Ager, Dr M S R Hutt and G Smith), 478

Detection of Tritium in Tissue Low-Temperature Autoradiography for the, with Removal of Luminescence induced by Tritium (P Pellerin, P Fallot, M Laine-Boszormenyi and F Serrel), 1385

Detection (Cytochemical), of Polyaldehyde Moieties in Sections and Smears Fluorescent Schiff-Type Reagents for (Prof Frederick H Kasten, Vivian Burton and Peggy Glover), 1797

Detection and Identification of the Polyphenoloxidase Substrate of the Banana (Dr L A Griffiths), 58
Detector (Radioactive Ionization Type) Analysis of Permanent Gases by Gas Chromatography using a (V Willis), 894
Detectors (New) The Importance of, *review*, 1260
Detergent (Cationic) Interaction between Nucleic Acid and a (Prof Dino Guerritore and Luciano Bellelli), 1638
Detergent (Paraffin-) Interactions in Aqueous Systems Solid State Rheological Study of the Mechanism of (F J Radd and L H Crowder) 443
Determinants of Survival in Intraperitoneal Infections of Mice Opsonins as (Dr C R Jenkin and Prof D Rowley), 474
Determination of Chlorine in Muscle Tissues by Neutron Activation Analysis (Dr Jonas Bergstrom), 1504
Determination of Glucosamine Synthesis Interfering Substances in the (Dr Fiorenzo Paronetto), 1317
Determination of the Interaction of Deoxyribonucleate and Magnesium Ions by means of a Metal Ion Indicator (Joseph Shack and Barbara S Bynum), 635
Determination of ΔT from the Lunar Ephemeris and the Frequency of Caesium in Terms of U T $-\Delta T$ An Error in the (C A Murray), 441
Determination of Magnesium in Blood Serum by Atomic Absorption Spectroscopy (Dr J B Willis), 186
Determination of Suitable Buffer Systems for Countercurrent Distribution A Paper-Chromatographic Method for the (Andrzej Waksmundzki and Edward Soczewinski), 977
Determination of the Temperatures of Ancient Seas by the Measurement of the Oxygen Isotopes Ratio in Fossil Calcareous Organisms (Y A Birstein) 1025
Determination of Tissue Mucoproteins (Luiz A Abreu and R Raposo Abreu), 2016
Determination of Xanthine Oxidase Activity using the Oxygen Electrode A Rapid and Sensitive Method for the (Metry Bacila and Dr Gilberto G Villela), 1394
Determination (Age), in *Mansonioides* Mosquitoes (R H Wharton), 830
Determination (Age), in Wild Rabbits (R H Taylor), 1158
Determination (Colorimetric), of Elastin Some Improvements in (Dr V Scarselli), 1563
Determination (Electrical) of Transport of 3-Indole Acetic Acid in *Avena* (I A Newman) 1728
Determination (Polarographic), of Serine A Micromethod for the (J Ladik and Dr I Szekacs), 188
Determination (Quantitative) Occurrence and, of 2-Dimethylaminoethanol in Animal Tissue Extracts (Dr Conrad G Honegger and Ruth Honegger), 550, *erratum*, 1986
Determinations (Alkali Ion), by means of Glass Electrodes (Research Symposium at the University of Sheffield), 1616
Determining Carbon-14 by Combustion using Calcium Carbonate A Method for (E C S Little), 900
Determining the Fat Content of Algal Cells Value of a Simple Observational Technique for (Dr J H Evans), 1737
Determining Quality in Merino Wool Routine Methods for (P L le Roux) 917
Deuel, H Macromolecules (Inorganic and Organic/Inorganic Polymers), 1690
Deuterated Green Algae Chloroplast Pigments of (Harold H Strain, Henry L Crespi and Joseph J Katz), 730
Deuterium Oxide Culture of Algae and other Micro-organisms in (Henry L Crespi, Sylvia M Archer and Joseph J Katz), 729
    Effects of, on the Synthesis of *T*5 and *T*7 Bacteriophages (E L Rothstein, L A Manson, R Hartzell, jun , and David Kritchevsky), 1167
    Saliva-Serum Ratios of, after Administration of Heavy Water (Nan Taggart and Dr F E Hytten), 457
Deutsch, Dr K Coating of Red Blood Cells with Antigenic Substances, 278
Deutsche Bunsengesellschaft fur Physikalische Chemie and the Max-Planck Gesellschaft Colloquium on Fast Chemical Reactions in Solution, 1453
Deutsche Bunsengesellschaft fur Physikalische Chemie and the International Union of Pure and Applied Chemistry Symposium on Thermodynamics, 1606
Deutschen Gesellschaft fur Electronenmikroskopie Conference, 508
Developing Chicken Embryos Combined Effects of Cortisone and Insulin on (Dr Pietro de Franciscis and Prof Walter Landauer), 101
Developing Rat Brain Histochemical Study of Monoamine Oxidase in the (Nobuo Shimizu and Nogaaki Morikawa), 650
Development Antibacterial Substances of Coniferous Seedlings at Different Stages of their (R Vamos and L Vida), 915
    Colonial 680
    Haemoglobin Pattern of the Cyclostome *Pertromyzon planeri* during the Course of (M Adinolfi, G Chieffi and M Siniscalco), 1325
    Immunology and (edited by M V Edds, Jr), (Developmental Biology Conference Series, 1956 under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
    My Philosophical (Bertrand Russell), *review* by Prof R Braithwaite, 749
    Nuclear Power and its, 383
Development of the Aplacophorous Mollusc *Neomenia carinata* Tullberg (Dr T E Thompson) 122
Development of Bubble Chambers and some recent Bubble Chamber Results in Elementary Particle Physics (Dr D A Glaser), 954
Development of Connective Tissue Diaphragms for Analysing the (Prof Hans Selye), 701
Development of Even-Aged Plantations Pathogenic Factors in the Rooting Space and the (W R Day), B A 46
Development of Furnaces for Glass Melting (Dr W M Hampton), 772
Development of Iron and Steel Technology in China (Dr Joseph Needham), *review* by Prof F C Thompson, 1830
Development of Isolated Blastomeres of Mouse Eggs Experiments on the (Dr Andrzej K Tarkowski), 1286
Development of Nuclear Power, *review* by R Brightman, 1673
Development of Public Services in a Modern Democracy, 1087
Development of *Trypanosoma vivax* to the Infective Stage in Tsetse Fly Tissue Culture (Dr William Trager), B A 30
Development of the Yolk Nucleus in the Oocytes of some Fishes (Prof A Stolk), 1746
Development (Aeronautical Research and), Advisory Group for (Combustion and Propulsion Panel) Discussion on the Chemistry of Propellants, 778
    Discussion on Basic Problems in Propulsion, 779
Development (Executive) Sandwich Course in (Sheffield College of Technology), 235
Development (Foetal) Prevention of, by Enzyme Inhibition (Prof G Karlson and Elsa Rosengren), 1238
Development (*Gamma* Particles, Nadi-Positive Mitochondria, and), in the Water Fungi *Blastocladiella* and *Allomyces* (Prof Edward C Cantino and Gilbert Turian), 1889
Development (The Geological), of North America, *review* by Dr J W Cowie, 1600
Development (Limb), in the Absence of Ectodermal Ridge (Dr Eugene Bell, Dr John W Saunders, jun , and Dr Edgar Zwilling), 1736
Development (Management), a Systematic Approach to the Provision of Supervisors and Managers (F I de la P Garforth), 319
Development (Prenatal) Environmental Influences on (edited by Beatrice Mintz), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Development (Research and) Reviews of Data on No 13, Research and Development and Economic Growth (Dr A T Waterman), (United States National Science Foundation) 591
    Reviews of Data on, No 14, Funds for Research and Development Performance in American Industry (United States National Science Foundation) 1022
    Reviews of Data on, No 15, Grants for Private Philanthropic Foundations during 1957 (United States National Science Foundation), 1272
Development (Research and), at the Heston Laboratories of Atomic Power Constructions, Ltd , 517
Development Charges (Research and) in Civil Nuclear Power, 406
Development Commission Special Promotions, 859, 1273
Development Commission on Biological (Non-Medical) Problems of Nuclear Physics (Agricultural Research Council, the Medical Research Council and the) Appointment of Sir James Denby Roberts as chairman of the Joint Committee of the, 237
Development Commissioners' scheme Joint Meeting of the Challenger Society with representatives from the marine laboratories 410
Development Expenditure (Government Research and), in Britain Control of, 696
Development Performance in American Industry Funds for Research and (United States National Science Foundation, Reviews of Data on Research and Development No 14), 1022
Development Trends in Australian Scientific Research, 1027
Development and Economic Growth Research and (Dr A T Waterman), (United States National Science Foundation, Reviews of Data on Research and Development No 13), 591
Development and Growth of Cutaneous Melanoma in Killifish Hybrids Effect of Thiouracil and Thyroxine on (Prof A Stolk), 562
Developmental Biology, No 1, 236
Developmental Biology, *review* by Dr D R Newth, 839
Developmental Biology Conference Series, 1956—Cytodifferentiation (edited by Dorothea Rudnick) Environmental Influences on Prenatal Development (edited by Beatrice Mintz) Regeneration in Vertebrates (edited by Charles S Thornton) , Embryonic Nutrition (edited by Dorothea Rudnick) , Immunology and Development (edited by M V Edds, Jr) , Dynamics of Proliferating Tissues (edited by Dorothy Price) , Wound Healing and Tissue Repair (edited by W Bradford Patterson), (United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Developments in Thermodynamics (Dr H A Skinner, K Schafer and J S Rowlinson), 1606
Developments (Economic), in the Middle East, 1957-1958 (Supplement to World Economic Survey, 1958) (United Nations), 1280
Developments (New), in Training—Five Studies in the Efficient Communication of Skills (edited by Frank A Heller) 421
Developments (Newer) in the Chemistry of the Non-Metals (Kingston Technical College Course of Lectures on), 1915
Developments (Recent), in Textile Chemistry (Bradford Institute of Technology, the Bradford Chemical Society and the Yorkshire Council for Further Education Symposium on) 1845
Developments (Scientific) Mass Media of Communication and, 659
Developments (Scientific) in Britain, 1190
Developments and Trends in Palaeontology Recent (Prof O M B Bulman), B A 42
Deviation of Zone Lenses produced by Polarization (Prof Jurgen R Meyer-Arendt), 811
Devices (Semiconductor) Transistors and Associated (Electronics and Communications Section of the Institution of Electrical Engineers International Convention on), 693
Devreux, M , et autres Recherches sur l'Autostérilite du Caféier robusta (*Coffea canephora* Pierre) 518
Dewar Prof M J S Nitration of Hydrocarbons and other Organic Compounds *review*, 577
    Aromatic Substitutions, *review*, 925
Dewdney, D A C Opening Address at the Symposium at Queen Mary College on the Oxidation of Organic Compounds, 326
Dewhirst, Dr D W (Blackwell Dr D E , and) Kellogg and Ney's Model of the Solar Corona 1120
Dexter, Dr D Appointed reader in morbid anatomy at St George's Hospital Medical School, London, 322
Dextran Release of Histamine from Rat Mast Cells by Blood treated with (Dr G T Archer), 1151
Dextran in Human Red Cells after Haemolysis Accumulation of (N V B Marsden and S G Ostling), 723
Dextran (Injected) Labelled with Tritium in Mice Fate of (Å Hanngren, E Hansson, S Ullberg and Prof B Åberg), 373
Dextran-producing Cultures of *Streptococcus bovis* Formation of Leucrose in (R W Bailey and Prof E J Bourne), 904
Dextransucrase Kinetic Study of, based on the Langmuir Adsorption Isotherm (W Brock Neely and C F Thompson), B A 64
Dhar, Dr N R Nitrogen Replenishment in the Soil (Presidential Address to the Indian Society of Soil Science), 942

Dherte, Dr Paulette, and others Haemoglobin *P* in a Family in the Belgian Congo, 1133
Dhont, J (Weurman, C, and) Unexpected Formation of Volatile Compounds on Gas–Liquid Chromatography Columns, 1480
Di Sabato, Dr G Effect of Reduced Diphosphopyridine Nucleotide on the Swelling of Isolated Mitochondria, *erratum*, 95
Di- and Tri-phosphate (Adenosine) Concentrations Changes in, in the Early Stages of the Action of Yeast on Glucose (Dr J O Laws and Dr L H Stickland), 1246
Diabetic Rats (Normal and) Release of Non-Esterified Fatty Acids from Adipose Tissue in (Dr E Wendeova and Dr J Pav), 1147
N,O-Diacetylneuraminic Acid and *N*-Acetylneuraminic Acid in *Escherichia coli* (Dr C W De Witt and J A Rowe), 381
Diadema setosum (Leske) Isolation of Echinochrome *A* from the Spines of the Sea Urchin (Kokichi Nishibori), 1234
Diagnosis, Improvement and Management of Salt-affected Soils (Unesco Middle East Science Co-operation Office Regional Training Course on), 1778
Diagrams (Constitutional), of Uranium and Thorium Alloys (Frank A Rough and Arthur A Bauer), *review* by Dr R E D Hughes, 925
Diagrams (Polar), of Birds Radar Echoing Area (J Edwards and E W Houghton), 1059
Dialysable (A Non-) Inhibitor of Glutamo-Transferase present in Excised Tomato Roots (C S Vaidyanathan and Prof H E Street), 347
Diamagnetic Anisotropy in Crystals Intermolecular Distances and, as Measures of the Polarity of Benzene and Borazole Substituents (Dame Kathleen Lonsdale), 1060
Diamantes de Angola, Companhia de Museu fo Dundo, Publicacoes Culturais No 37, Flagrantes da Vida na Lunda (Introducao de Dr José Osorio de Oliveira), 236
Diamine (Ethylene) Evidence of Side-Chain Cleavage during the Reaction of Epinephrine and Norepinephrine with (Dr Louis-P Joly and Dr Guy Nadeau), 1483
Diamine Tetra-acetate (Ethylene) Effect of, on Vitamin B_{12} Absorption in the Rat (Edward G Rice, Dr Samuel M Greenberg, John F Herndon and E J Van Loon), 1948
Diaminopimelic Acid Release of Compounds containing, from *Vibrio metchnikovi* treated with Antibody and Complement (Dr F Shafa and Dr M R J Salton), 1341
Diamond Intensity of the (111) Reflexion for (Prof R Brill and H Barth), 264
  Preparation of (Dr H P Bovenkerk, Dr F P Bundy, Dr H T Hall, Dr H M Strong and Dr R H Wentorf, jun), 1094
Diamond (Natural and Synthetic) Spiral and other Growth Forms of Synthetic Diamonds—a Distinction between (Prof S Tolansky and Dr I Sunagawa), 1526
Diamond (Semiconducting), after Heat Treatment Electrical Resistivity Changes observed in a (R E Mutch and Dr F A Raal), 1857
Diamonds (Synthetic) Spiral and other Growth Forms of—a Distinction between Natural and Synthetic Diamond (Prof S Tolansky and Dr I Sunagawa), 1526
Diapause Dormancy of the Khapra Beetle—Quiescence or (H D Burges), 1741
Diapause in the European Corn Borer, *Ostrinia nubilalis* (Hbn) (Lepidoptera Pyralidae) Chemical Changes associated with (J A Mutchmor and J H Maruzek), 1077
Diaphragm (Rat) Salicylate and Potassium Fluxes of (Dr J A Hicklin), 2029
Diaphragm (Rat), *in vitro* Role of Magnesium in the Insulin-Sensitivity of the (Dr Gangagobinda Bhattacharya), 1401
Diaphragm Muscle (Rat) Monosaccharide Transport in (F C Battaglia and P J Randle), 1713
Diaphragms for Analysing the Development of Connective Tissue (Prof Hans Selye), 701
Diatom from the Antarctic An Unusual (E J Ferguson Wood), 1962
Diazotization Measurement of Inhibition by Azide in Biochemical Assay Systems involving Nitrite Estimation by (Dr E J Hewitt and D G Hallas), 1485
Diazotization Procedures used in Biological Assay Systems Interference by Azide with (J R Villanueva), 549
2 5-Dicarbethoxy-3 4-Dihydroxy-Thiophene Inhibition of Tumour Growth with (Dr M B Sahasrabudhe, M V Narurkar, L B Kotnis, B D Tilak and M D Bhavsar), 201
Dickens, F Enzymes (Regulation of Enzymic Reactions within the Cell), 688
Dickins, Dr B G Promoted to Chief Scientific Officer and appointed director general of atomic weapons in the Ministry of Supply, 232 , work of, 232
Dickinson Memorial Lecture (Second Biennial), to the Newcomen Society, 1956 (Dr Joseph Needham), *review* by Prof F C Thompson, 1830
Dickson, A D, and others Production of Emetic Material by Species of *Fusarium*, 1319
Dickson, Prof J G, and others Production of Emetic Material by Species of *Fusarium*, 1319
Dictionary of Metallurgy (Dr A D Merriman), *review* by Prof F C Thompson, 1765
Die-Back in Yellow Lupins High Levels of Phosphorus and (R G Warren and B Benzian), 1588
Dieldrin Mechanisms of Resistance of Adult Houseflies to the Insecticide (F P W Winteringham and A Harrison), 608
  Resistance of Houseflies to γ-Benzene Hexachloride and (R G Bridges and J T Cox), 1740
Dielectric Absorption in Dispersed Systems (G A Johnson and Dr S A Neale), 898
Dielectric Studies on Deoxyribonucleic Acid (H G Jerrard and B A W Simmons), 1715
Dielectrics, *review* by Dr V Daniel, 1175
Dielectrics Progress in (edited by Dr J B Birks and Dr J H Schulman), Vol I, *review* by Dr V Daniel, 1175
Dierick, W, and others Influence of X-Rays on the Activity of Carbonic Anhydrase in Erythrocytes and on their Haemolytic Resistance, 111
Diet Effect of, on the Blood Sugar and Liver Glycogen Level of Normal and Adrenalectomized Mice (B P Block and Dr G S Cox), 721
Diet in Aminoaciduria caused by Maleic Acid Significance of Lactose in the (Stefan Angielski and Jerzy Rogulski), 276
Diet containing Roughage Experimental Production of Magnesium Deficiency in Lambs on a (Dr D M McAleese and Dr R M Forbes), 2025
Diet (Clover-free) Implications of Restricting Cows to a, in order to Reduce the Strontium Content of Milk (Dr David Purves), 1408
Diet (Human) Strontium-90 in, in the United Kingdom (Agricultural Research Council), 1111
Dietary Factors in the Homograft Reaction (Dr A S Parkes), 699
Dietary Fat and Extent of Blood Sampling Effect of, on the Level of Plasma Cholesterol in the Rat (I Coleman and J M R Beveridge), 1041
Dietary Protein and Serum Cholesterol in Rats (A P de Groot), 903
Dietary Protein Percentage Influence of, on Growth of Wool (K A Ferguson), 907
Dietrich, Prof G Polar Front Survey—Hydrography (Greenland and Norwegian Seas), 1181 , (Shetland–Faroe–Iceland Region), 1182 , (North Atlantic Ocean), 1182
Difference between the Catalases of Acid-fast Bacilli (Wieslaw Tysarowski and Stanislaw Kwiek), 1513
Difference in Heat Tolerance Exhibited by *Bos taurus* and *Bos indicus* Beef Cattle A Possible Explanation for Part of the (H P Ledger), 1405
Difference between Lattice Constants of Copper dipyridine dichloride and dibromide Influence of the Size of the Halogen Atom on the (Vladimir Kupcik and Slavomil Durovic), 1060
Difference (Sex), in Ethanol Tolerance of Rats (Henrik Wallgren), 726
Difference (Sex), in the White Blood Cells of Rats (*WR* Strain), (Dr Hans Meier), 1082
Different Ages Enzymes and Radioactivity in Erythrocytes of (Dr Lester M Levy Harry Walter and Martin D Sass), 643
Different Cell–Virus Relationships Formation of, in Tumour Cells induced by Polyoma (Dr Leo Sachs and Ernest Winocour), 1702
Different Heating Rates Number of Free Radicals in Coal during Carbonization at (J Smidt and Prof D W van Krevelen), 719
Different Size Classes in Non-diabetic Humans of Varying Ages Actual Distribution of the Number and Volume of the Islets of Langerhans in (Bo Hellman), 1498
Different Stable *L* Forms of *Proteus P* 18 Distribution of Nucleic Acids among (Prof P Mandel, M Sensenbrenner, P De Gregorio and A M Bader), 566
Different Stages of their Development Antibacterial Substances of Coniferous Seedlings at (R Vamos and L Vida), 915
Different Tissues and Subcellular Fractions Distribution of Enzyme Systems responsible for Steroid Metabolism in (Virandra B Mahesh and Frank Ulrich), 1147
Different Wild-Type Isoalleles Effect of, on Crossing-over in *Drosophila melanogaster* (M M Green), 294
Differential Analysis of the Effects of Phenothiazine-Tranquillizers on Emotional and Motor Behaviour in Experimental Animals (Dr M Taeschler and Dr A Cerletti) 823
Differential Equations Ordinary (Dr Wilfred Kaplan), *review* by Prof T A A Broadbent, 6
Differential Equations for Instrumentation Engineers, *review* by Prof T A A Broadbent, 6
Differential Equations (Partial) Numerical Analysis and (George E Forsythe and Paul C Rosenbloom), *review* by Prof T A A Broadbent, 576
Differential and Interference Distances of Chiasmata Simultaneous Change in both (Dr J Yanney Wilson), 207
Differentiation between a Growth-Promoting Factor and a Tumour-Susceptibility Factor in Eggs (Charles H Hill and Henry W Garren), 824
Differentiation (Liquation), in Magma (V I Lebedinsky), 1025
Differing Biological and Physical Properties Turnip Yellow Mosaic Virus Nucleoprotein Particles with (R E F Matthews), 530
Difficulties in the Present Systems of Superannuation, 503
Diffraction (X-Ray), by Carbons Effects of Heating on (Eitaro Matuyama), 544
Diffraction Pattern (Electron) Structure of Precipitated Cadmium Sulphide as studied by Single-Crystal (Dr Ryoitiro Sato), 2005
Diffraction Pattern (X-Ray), of Carbide in Low-Carbon Iron-Silicon Alloys (G Konoval, L Zwell, L A Gorman and W C Leslie), 1862
Diffuse in Nervous Action The Discrete and the (James Arthur Lecture on the Evolution of the Human Brain), (Prof D P C Lloyd), 1777
Diffusion of Exchangeable Cations in Vermiculite (G F Walker), 1392
Diffusion of a New Habit among Greenfinches (Dr Max Pettersson), 649
Diffusion (Agar) Estimation of Vitamin C by (Alan H Chaiet and Louis Chaiet), 1487
Diffusion ('Eddy'), in Chromatography (J Calvin Giddings), 357
Diffusion (Intergranular), in a Silicate System Measurement of—Iron in Forsterite (Prof John J Naughton and Yasuo Fujikawa), B A 54
Digest of Soviet Technology, No I (Engineering Information Services, Ltd), 320
Digital Computers (British Council Course on) 1450
Digitalinum Verum (16-Acetyl) Chemistry and Pharmacology of (Z Kanda, Prof A Sekiya, K Katayama, A Okano and T Miki), 1414
1,4-Dihydrazinophthalazine Effects of, on Organ Content and Adrenal Medullary Secretion of Catechol Amines (M Bydgeman and L Stjarne), 1646
Dihydro- and Tetrahydro-1-naphthoic Acids (5- and 8- Halogeno) Plant Growth Activities of (Toshio Fujita, Sadao Imai, Koichi Koshimizu, Tetsuo Mitsui and Jiro Kato), 1415
Dihydrostreptomycin Interaction of Streptomycin and, with Apo- and Co-dehydrogenases (Prof K Michalska), 987
Dijksterhuis, Prof E J History of Cosmology, *review*, 836
$\alpha\epsilon$-Diketopimelic Acid Synthesis of Dipicolinic Acid from (the late Joan F Powell and R E Strange), 878
Diluents (Organic) Effect of Emulsifiers and, in Soil Insecticide and Nematicide Formulations (F T Phillips), 1512
Dilute Binary Solid Solutions of Bismuth in Tellurium and Tellurium in Bismuth Some Semiconductive Properties of (Dr Tomasz R Piwkowski), 355
Dimbat, M, and others Carrier Gas and Sensitivity in Gas Chromatography, B A 54
6,7-Dimethoxy*iso*quinoline-1-aldoxime Berberine Alkaloids via (Dr C K Bradsher and Dr N L Datta), 1943
2-Dimethylaminoethanol in Animal Tissue Extracts Occurrence and Quantitative Determination of (Dr Conrad G Honegger and Ruth Honegger), 550, *erratum*, 1986

1,3-Dimethylthymine Ultra-violet Irradiation of (Shih Yi Wang), B A 59
Dimorphism and Size Distribution in *Velella* and *Physalia* (Prof Robert Bieri), 1333
Dineley, Dr D L Appointed lecturer in geology at the University of Bristol, 1613
Dingle, Prof H Scientific Research and the Philosophy of Science, 1193
Dingman, Prof Joseph F (Arimura, Akira, and) Specific and Sensitive Assay Method for Vasopressin and Oxytocin using Glass-Paper Chromatography, 1874
Dinitrophenol Need for Inorganic Phosphate in Oxidations stimulated by (P Borst and Prof E C Slater), 1396
2 4-Dinitrophenyl Amino-Acids Detection of, on Paper Chromatograms (Dr A H Maddy), 1397
Dinucleotide (Flavin Adenine) Binding of the Sulphydryl Group in D-Amino-Acid Oxidase Apo-Protein with (Dr Kunio Yagi and Takayuki Ozawa), 1227
    Change of Absorption Spectrum of, by its Binding with both D-Amino Acid Oxidase Apo-Protein and Benzoate (Dr Kunio Yagi, Takayuki Ozawa and Minoru Harada), 1938
Dioctyl Sodium Sulphosuccinate Registration of the Spermicidal Effects of (Prof Per Eric Lindahl and Kjell Wedin), 1289
Dioxide (Carbon) Vibrational Relaxation and Dissociation of, behind Shock Waves (Dr I R Hurle and Dr A G Gaydon), 1858
Dioxide (Carbon), in Water in Wine in Beer and in other Beverages (F Justin Miller), *review* by Dr A H Cook, 302
Dioxide (Hydrogen, Carbon), and Air Habit of Ice Crystals grown in, at Reduced Pressure (A P van den Heuvel and Dr B J Mason) 519
Dioxide (Carbon) Output of Individual Insects The Infra-Red Gas Analyser as a Means of Measuring the (Dr A G Hamilton), 367
Dioxide (Carbon-14) Experiments with Hydrocortisone Liver Glucosyl Oligosaccharides and Glycogen— (Dr Hsien-Gieh Sie, Prof James Ashmore, Dr Robert Mahler and Prof William H Fishman), 1380
Dioxide (Manganese) Action of, on Simple Carbohydrates (Dr J L Bose, Dr A B Foster, Prof M Stacey and Dr J M Webber), 1301
Dioxide (Sulphur) Inhalation Influence of, on the Phagocytic Activity of the Macrophage System (Prof D L J Bilbey and Dr H Salem), 722
Dioxide (Titanium) Pigment Particles Forces between (James E Latty and Dr W C Clark), 49
Diphosphopyridine Nucleotide Effect of Reduced, on the Swelling of Isolated Mitochondria (Dr G Di Sabato), *erratum*, 95
Diphosphopyridine Nucleotide from Nicotinamide Synthesis of, by Slices of Liver (C J Threlfall), 60
Diphosphopyridine Nucleotide Oxidation Inhibition of Reduced, by Ammonia (R T Wedding and H M Vines), 1226
Diphtheric Intoxication (Experimental) Effect of Tranquillizing Drugs on Survival from (Prof Leo Greenberg and Dr James W Ingalls), 1721
Dipicolinic Acid Synthesis of, from *αε*-Diketopimelic Acid (the late Joan F Powell and R E Strange), 878
Dipterocarpaceae Chemistry and Taxonomy in the (Dr E C Bate-Smith and Dr T C Whitmore), 795
Dipyridyl Quaternary Salts Redox Properties of some (R F Homer and T E Tomlinson), 2012
Direct Continuous-Wave Reflexion Apparent Observation of Solar Corpuscular Clouds by (Dr. John D Klaus and W Reed Crone), 965
d c Stabilization of Transistor Circuits Use of the Silicon Resistor in the (J T Zakrzewski and D H Mehrtens), 811
Direct Effect of Erythropoietin on Human Erythroid Cells *in vitro* Lack of (Edward L Alpen, L G Lajtha and Donald C Van Dyke), 1228
Direct Spectroscopic Examination of Electrophoretic Zones in Agar Gel (Dr G H Beaven and W B Gratzer), 359
Directional Observations of Radio Noise from the Outer Atmosphere (G R A Ellis and D G Cartwright), 1307
Directional Sensitivity A Functional Interpretation of the Electron-Microscopic Structure of the Sensory Hairs in the Cristae of the Elasmobranch *Raja clavata* in Terms of (Prof O Lowenstein and J Wersall), 1807
Directory of Nuclear Reactors (International Atomic Energy Agency), Vol I, Power Reactors, *review* by Dr A J Salmon, 1438
Disappearance from the Blood of Promethium-147 in Rats Hormone Effects on Early Distribution and (Dr Bergene Kawin), 1816
Disappearance of the Erythropoietic Factor from Plasma of Anaemic Dogs after Nephrectomy (Dr Jean-Pierre Naets) 371
Disaster Food for Survival after a (Dr R C Hutchinson), *review* by M W Grant, 841
Discarded Blood Bank Blood as a Source of Protein for Cultivation of HeLa Cells (Billy R Blakey and Prof George E Gifford), 1158
Discharge (Corona) Light from the (Dr R W E Cook), 1055
Discharges (Cosmical Electrical) The Temperature required for Nuclear Reactions in (Dr C E R Bruce), 2004
Discharges (Electrical) Insulating Particles on Cathode Surfaces—their Effect upon (L B Griffiths and P C L Pfeil), 1475
Discipline of the Scientific Method, 295
Discoloration (Tallowy), in Cheddar Cheese—Fat Oxidation and Trace Metals in Cheddar Cheese (F Bishop), 1295 Fat Oxidation and Haematin Systems in Cheese (C G Rammell), 1296
Discontinuity (Mohorovičic) etc Depth of Isostatic Compensation and, in Continental and Oceanic Areas (J N Nanda), 629
Discontinuity (Weld Structure) Crack Behaviour at a (F J Radd), 543
Discovery Patterns of (Prof Norwood Russell Hanson), *review* by Gerd Buchdahl, 572
Discrete and the Diffuse in Nervous Action (James Arthur Lecture on the Evolution of the Human Brain), (Prof D P C Lloyd), 1777
Discrimination between Ebb and Flood Tide in Migrating Elvers (*Anguilla vulgaris* Turt) by means of Olfactory Perception (F Creutzberg), 1961
Discrimination of Xylose from Arabinose and some other Sugars (B Drozdz), 1395
Disease (Chagas's) International Congress on (Dr J D Fulton), 1114
Disease (Foot-and-Mouth) Effect of Proflavine on the Formation of the Virus of, and its Infective Ribonucleic Acid in Pig Kidney Tissue Culture Monolayers (F Brown and Doreen L Stewart), B A 74
Disease (A Suspected Virus), of the Citrus Red Mite *Panonychus citri* (McG), (Dr Kenneth M Smith, G J Hills, F Munger and J E Gilmore), 70
Disease (A Virus), of *Meloidogyne incognita incognita*, the Southern Root Knot Nematode (J R Loewenberg, T Sullivan and M L Schuster), 1896
Disease of Mice (Tyzzer's) Pure Culture of the Pathogenic Agent of (Dr K Kanazawa and A Imai), 1810
Diseases Biological Problems arising from the Control of Pests and (Institute of Biology Symposium on), 1100
Diseases in Agricultural and Horticultural Crops The Control of Pests and (G L Hey and K Marshall), *review* by F C Bawden, 1258
Diseases (Plant), caused by Arabis Mosaic Virus Role of a Dagger Nematode (*Xiphinema* sp) in Outbreaks of (Dr B D Harrison and Dr C H Cadman), 1624
Diseases (Thalassaemia) Genetic Basis of the (Prof V M Ingram and A O W Stretton), 1903
Diseases and Pests of Farm Crops Recognition of (Ernst Gram, Prosper Bovien and Chr Stapel), *review* by F C Bawden, 1258
Disitzer, L V , and others Electrophoretic Heterogeneity of Trypsin, 1225
Dislocation Arrangements in Molybdenum (J F Kerridge, A A Johnson and H I Matthews), 356
Disney, H J de S , and others Duration of the Regeneration Period of the Internal Reproductive Rhythm in a Xerophilous Equatorial Bird, *Quelea quelea*, 1659
Disorder Essential Pentosuria—Renal or Enzymic (Dr R C Bozian and Prof Oscar Touster), 463
Disorganization of the Secondary Structure in Proteins exposed to Ionizing Radiations in the Solid State (Dr Peter Alexander, L D G Hamilton and Dr K A Stacey), 226
Dispersal of Flowering Plants Origin and (Prof A S Boughey), 1200
Dispersed Sodium Ultrasonically (M W T Pratt and R Helsby), 1694
Dispersed Systems Dielectric Absorption in (G A Johnson and Dr S A Neale) 898
Disposal of Radioactive Waste (K Saddington and W L Templeton), *review*, 301
Disposal (River Pollution Sewage), and Trade Waste Treatment (Department of Civil Engineering and the Department of Extra-Mural Studies in the University of Birmingham Course on), 1451
Dispute (Printing) *Nature* and the Recent, 919
Dissimilation (Oxidative), of *p*-Aminobenzoic Acid by *p*-Aminosalicylic Acid Antagonism of the (Prof Norman N Durham and Jerry S Hubbard) 1398
Dissociation of Carbon Dioxide behind Shock Waves Vibrational Relaxation and (Dr I R Hurle and Dr A G Gaydon), 1858
Dissociation of the 'Surface Membrane Complex' in Atrophic Muscle Fibres (Dr R Birks, Prof B Katz and Dr R Miledi), 1507
Distances (Differential and Interference), of Chiasmata Simultaneous Change in both (Dr J Yanney Wilson), 207
Distances (Immunological), among some Gallinaecous Birds (Danilo Mainardi), 913
Distances (Intermolecular), and Diamagnetic Anisotropy in Crystals as Measures of the Polarity of Benzene and Borazole Substituents (Dame Kathleen Lonsdale), 1060
Distemper Virus (Canine) in Tissue Culture An Attenuated Strain of (Prof Gunnar Rockborn), 822
Distension (Localized), of the Oesophagus in Decerebrate Sheep Responses to (Prof A F Sellers and Dr D A Titchen), 645
Distilled Water 'Deminrolit Plants for (Permutit Co , Ltd), 25
Distinct Sectors in Polymer Single Crystals Evidence for (D C Bassett, Prof F C Frank and Dr A Keller), 810
Distinction between Natural and Synthetic Diamond Spiral and other Growth Forms of Synthetic Diamonds—a (Prof S Tolansky and Dr I Sunagawa), 1526
Distinction (Serological), of Adult and Foetal Human Haemoglobin (G R E Naylor and M E Adair), 1854
Distinguishable Coins (Partially) Heads-Tails Statistics for Two (Gabriel Weinreich), 1825
Distinguishing Bovine Type Tubercle Bacilli from other *Mycobacteria* Nicotinamidase in *Mycobacteria*—a Method for (Dr Kiyoshi Konno, Dr Hideo Nagayama and Dr Sutemi Oka), 1743
Distinguishing between α- and β-Glycosides by the use of Plant Haemagglutinins (Lectins) A Method for (Dr O Makela), 111
Distribution Relict Faura of Ennerdale Water—a Problem of (Dr W Pennington), 1421
Distribution of Ascorbic Acid in the Leaves of some Plants (Dr Philippe Hagene), 284
Distribution of British Books and Films Overseas, 1448
Distribution of 5-Carboxymethylhydantoinase (Dr Lloyd H Smith, jun , Faith A Baker, Margaret Sullivan and Lawrence J Kunz), 1314
Distribution of Enzyme Systems responsible for Steroid Metabolism in Different Tissues and Subcellular Fractions (Virendra B Mahesh and Frank Ulrich), 1147
Distribution of Flares on the Solar Disk Associated with Noise (L R McNarry) 806
Distribution of Hydrogen Structure of Bituminous Coals—Evidence from (Dr P H Given), 980
Distribution in the Mouse of Lethal and Sub-Lethal Doses of Cottonmouth Moccasin Venom labelled with Iodine-131 (Prof J F Gennaro, jun , and H W Ramsey), 1244
Distribution of Nucleic Acids among Different Stable *L* Forms of *Proteus P* 18 (Prof P Mandel, M Sensenbrenner, P De Gregorio and A M Bader), 566
Distribution of Promethium Plasma Fractions in Rats (Dr Bergene Kawin), 1722
Distribution of Protein Synthesis Effect of Protein Depletion on the, (Dr John Waterlow), 1875
Distribution of Radioactive Barium in Eye Tissues (R J Garner), 733
Distribution of Scientific Publications in Under-developed Countries (Scientific Publications Council Discussion on), B A 22
Distribution of Sodium in Compact Bone, as revealed by Autoradiography of Neutron-activated Sections (Prof J Vincent), 1332
Distribution (Actual), of the Number and Volume of the Islets of Langerhans in Different Size Classes in Non-diabetic Humans of Varying Ages (Bo Hellman), 1498
Distribution (Chromium), around Grain Boundary Carbides found in Austenitic Stainless Steel (B E Hopkinson and K G Carroll), 1479
Distribution (Countercurrent) A Paper-Chromatographic Method for the Determination of Suitable Buffer Systems for (Andrzej Waksmundzki and Edward Soczewinski), 977

Distribution (Counter-Current), of Proteins in Aqueous Polymer Phase Systems (Per-Ake Ålbertsson and Ed Jacques Nyns), 1465, *erratum*, 1688
Distribution (Early), and Disappearance from the Blood of Promethium-147 in Rats Hormone Effects on (Dr Bergene Kawin), 1816
Distribution (Size), in *Velella* and *Physalia* Dimorphism and (Prof Robert Bieri), 1333
Distribution (World), of Atmospheric Water Vapour Pressure (G A Tunnell), B A 15
Disturbance in the Ionospheric F-Region following the Johnston Island Nuclear Explosion (C H Cummack and G A M King) B A 32
Disturbance (Geomagnetic) Correlation between Earth-Current and (V P Hessler and E M Wescott), 627
  Diurnal Variation of Aurora and, at New Zealand Antarctic Stations (Dr T Hatherton and G G Midwinter), 889
Disturbance (Geomagnetic), and Velocity of Slow-Drift Solar Radio Bursts (M B Wood and C S Warwick), 1471
Disturbances (Giant Travelling), and Sporadic *E* Ionization A Relation between (L H Heisler), 1788
Disturbances (Interfacial) in Gas–Liquid Systems Droplet Circulation and (Dr C Ramshaw and Dr J D Thornton) 719
Disturbed Days Geomagnetic Activity at Halley Bay on (J MacDowall), 1543
Dithiocarbamates of the Coinage Metals (Cu, Ag Au) Electron Spin Resonance and Divalency of some (Tore Vanngard and Stig Åkerstrom), 183
Dithiourethane Splenic Siderosis in Mice treated with (Prof P N Cowen), 366
Diuretic Activity Sulphonamides with (Dr W Logemann, Dr P N Giraldi and Dr M A Parenti), 1711
Diurnal Variation of Aurora and Geomagnetic Disturbance at New Zealand Antarctic Stations (Dr T Hatherton and G G Midwinter), 889
Diurnal and Nocturnal Conditions Changes in the Lacunal Parencyma of *Mimosa pudica* in (Hideo Toriyama), 737
Divalency Electron Spin Resonance and, of some Dithiocarbamates of the Coinage Metals (Cu, Ag, Au), (Tore Vanngard and Stig Åkerstrom), 183
Diverse Morphological Forms in *Convolvulus pluricaulis* Chois Intraspecific Polyploidy and Evolution of (Dr S L Tandon and C P Mzalik), 481
Diversion of Saliva from the Actively Fermenting Rumen of Sheep Relationship between *p*H and Volatile Fatty Acid and (W R McManus), 1572
Divorce Statistics in Britain, 1107
Divorce Statistics Marriage and (Demographic Yearbook 1958, Special Topic), (United Nations), *review*, 1525
Dixon, Dr D Nuclear Forces and the Few-Nucleon Problem (Photonuclear Reactions with Light Nuclei), 1113
Dixon, Dr Malcolm Enzymes in the Food Industry, 1366
Dixon, Dr Malcolm, and Webb, Dr Edwin C Non-Inverted versus Inverted Plots in Enzyme Kinetics, 1298
Doak, S (Koller, P C, and) Biological Effects of Low Doses of Ionizing Radiations (Immunological Aspects of Tissue Transplantation after 300 r of X-Rays), 1113
Dobryszycka, W, and others Regeneration of Protein from Insoluble Protein-Tannin Compounds, 1799
Documentation Service A New Geological, 153
Documents Newtonian, *review* by Dr M A Hoskin, 1750
Dodd, Dr J M, and others Force-Feeding Fish under Experimental Conditions, 1660
Dodd, Dr M H I, and others Force-Feeding Fish under Experimental Conditions, 1660
Dodgson, K S (Lloyd, Dr A G, and) Infra-Red Spectra of Carbohydrate Sulphate Esters, 548
Does an Increase in the Tension in a Ligament elicit Reflex Muscular Responses ? (Dr Bertil Stener), 1495
Dog (Anaesthetized) 'Supercarbia' in the (Dr G R Graham, D W Hill and J F Nunn), 1071
Dogs (Anaemic), after Nephrectomy Disappearance of the Erythropoietic Factor from Plasma of (Dr Jean-Pierre Naets), 371
Dolder, K Thermonuclear Research (Shock Waves in Gases), 1017
Dole, Prof M, and Williams, Dr T F Energy Transfer with special reference to Biological Systems (Disappearance of Unsaturated Linkages on γ-Irradiation of Polyethylene), 689
Dole, S H, and Margolis, M A Chemistry of Propellants (Sources, Availability and Estimated Cost of Propellants), 778
Dolerite Intrusions from the Theron Mountains and Whichaway Nunataks, Antarctica Palaeomagnetism of some (D J Blundell and P J Stephenson), 1860
Dolezilova, L, and others An Electron-Microscopic Study of Spores of Morphological Variants of *Streptomyces erythreus* Strains, 1888
Doll, Dr R, and others Dose–Response Relationship in Radiation Leukaemia, 1669
Dolman, Prof Claude E, and others Statement on Biological and Chemical Warfare, 1018
Domb, Prof C Fluctuation Phenomena and Stochastic Processes, 509
Domestic Animals Reproduction in (edited by H H Cole and P T Cupps), Vol 1, *review* by Dr S J Folley, 1091
Domination (Photopositive), in a Scolytid Beetle Release by Exercise Flight of a Chemotropic Response from (Prof Kenneth Graham), 283
Domingo, V and others Two Cases of Triple Fission of Uranium-235, 1057
Donaldson, P E K Electronic Apparatus for Biological Research, *review* by W J Perkins, B A 4
Donaldson, P E K (Barlow, Dr H B, and) Awarded a grant of £1,000 by the Paul Instrument Fund Committee of the Royal Society, 507
Donaldson, W F, and others Coal Science (Ultra-fine Structure of Coals and Chars), 413
Donhoffer, Prof Sz and others Thermo-regulatory Heat Production in the Brain, 993
Donnay, Prof J D H Twinning of Crystals (A Crystal Twins whenever there is a Superlattice that has more Symmetry than the Actual Lattice of the Crystal), 1911
Donor Cells (Proliferating), in Chick Embryos injected with Adult Chicken Blood Cytological Identification of (P M Biggs and L N Payne), 1594
Donors (406 French Blood) Frequencies of the Haptoglobin Groups in (Dr J Moullec and Dr J M Fine), 196
Dorf, E Origin and Dispersal of Flowering Plants (Angiosperms in various Tertiary Floras of Wyoming), 1201
Dormancy of the Khapra Beetle—Quiescence or Diapause (H D Burges), 1741
Dormancy (Extended), of Deciduous Woody Plants treated in Autumn with Gibberellic Acid (Dr P W Brian, J H P Petty and P T Richmond), 69
Dormancy (Seed) Prevention of the Onset of, by Gibberellic Acid (Dr M Black and J M Naylor), 468, *erratum*, 857
Dorsal Aorta of certain Fishes A Ligament in the (Dr L L de Kock and Dr S Symmons), 194
Dorsal Tegmental Nuclei A Heat-Loss Mechanism involving the Habenular, Interpeduncular and (B G Cragg), 1724
Dorst, T At the 139th Annual Meeting of the Swiss Society for Natural Sciences (La Signification des Galapagos pour l'Etude de l'Évolution), 1454
Dose Fractionation An Effect of, on the Incidence of Bone Tumours using Radioactive Phosphorus (Dr N M Blackett) 565
Dose–Response Relationship in Radiation Leukaemia (Dr P Armitage, Dr W M Court Brown and Dr R Doll), 1669, (Dr D J Mewissen) 1670
Doses (Lethal and Sub-Lethal), of Cottonmouth Moccasin Venom labelled with Iodine-131 Distribution in the Mouse of (Prof J F Gennaro, jun, and H W Ramsey), 1244
Doses (Low), of Ionizing Radiations Biological Effects of (Unesco, the International Atomic Energy Agency and the Comitato Nazionale per le Richerche Nucleari Symposium on), 1111
Dosimeter (A Sensitive Chemical), for Ionizing Radiation (Prof Gerald Oster and Dr Barret Broyde) 545
Dossett, H A (edited by G Sell and) Handbook of the Petroleum Industry, *review*, 1832
Doudney, C O Macromolecular Synthesis in Bacterial Recovery from Ultra-violet Light, 189
Doudney, C O, and Haas F L Effect of Purine and Pyrimidine Analogues on Reversion of a Tryptophan-requiring Strain of *Escherichia coli*, 114
Dougherty, Dr Ellsworth C, and others Photoreactive Pigments in Flagellates—Chromoprotein Pigments of some Cryptomonad Flagellates, 1047
Douglas, Dr A S The British Computer Society—First Conference, 945
Douglas, Prof R W The Structure of Glass *review*, 134
Dounreay Fast Breeder Reactor Criticality of the, 1449
Dowben, Dr Robert M Prolonged Survival of Dystrophic Mice treated with 17α-Ethyl-19-Nortestosterone, 1966
Dowden, R L Low-Frequency (100 kc /s) Radio Noise from the Aurora, 803
Dowdeswell, W H Practical Animal Ecology, *review* by Prof J B Cragg, 1262
'Dowex-I' (Resin,) Chemical Activities of *E coli* adsorbed on a (Tsutomu Hattori and Choseki Furusaka), 1566
Downes, A M, and Lyne, A G Measurement of the Rate of Growth of Wool using Cystine labelled with Sulphur-35, 1884
Downstream Migration Retinal Responses of Pink Salmon associated with its (Dr M A Ali and Prof W S Hoar), 106
Dragon Project of the Organization for European Economic Co-operation, 24, 942
Drake, J M F, and others Energy Transfer with special reference to Biological Systems (Chelates of Iron as Models for the Understanding of the Variations in Spectrum and Redox Potential of the Cytochromes), 690
Drakeley, Dr T J (edited by) Annual Report on the Progress of Rubber Technology (Institution of the Rubber Industry), 854
Dresskamp, H (Burton, Prof M, and) Energy Transfer with special reference to Biological Systems (Measurement of Luminescence Decay Times in Scintillator Systems) 689
  Fast Chemical Reactions in Solution (Direct Measurement of Energy Transfer Processes), 1454
Drenth, J, and Jansonius, J N The Unit Cell of Mercuripapain Crystals, 1718
Driftwood Transport of, from South America to Tasmania and Macquarie Island (Prof H N Barber, Dr H E Dadswell and H D Ingle), 203
Driver Behaviour A Simulator for Research on (Prof J H Mathewson), 237
Droplet Circulation and Interfacial Disturbances in Gas–Liquid Systems (Dr C Ramshaw and Dr J D Thornton), 719
Droplets (Water) Supercooling of (P G Fox), 546
Dropping Mercury Electrode Reduction of the $FeS_2O_3^+$ Ion at the (F M Page), 1481
Drosophila and other Flies Plastron Respiration in the Eggs of (Dr H E Hinton), 280
Drosophila melanogaster Complementation among the Sub-Genic Mutants in the *r*-Locus of (Dr O G Fahmy and Dr Myrtle J Fahmy), 1927
  In vitro Cultivation of Blood Cells of, in a Synthetic Medium (Dr Masakatsu Horikawa and Dr Yukiaki Kuroda), 2017
  Effect of Different Wild-Type Isoalleles on Crossing-over in (M M Green), 294
  Genetic Control of Tryptophan Peroxidase-Oxidase in (Corrado Baglioni), 1084
Drosophila (Adult) Synthesis of Deoxyribonucleic Acid in (Per Oftedal), 1961
Drozdz, B Discrimination of Xylose from Arabinose and some other Sugars, 1395
Drug (Anti-coagulant), Pelentane or Thromexane Isomeric O-Methyl Ethers of Ethyl di-(4-hydroxycoumarinyl-3)-Acetate, the (Dr Eduard Knobloch), 1568
Drug-Metabolizing Enzymes Stimulatory Effect of Foreign Compounds on Ascorbic Acid Biosynthesis and on (Dr A H Conney and Dr J J Burns), 363
Drugs Man-made, *review* by F R Batchelor, 1597
Drugs (Ganglion Blocking) Action of, on Choline Acetylase (Dr J E Gardiner), B A 71
Drugs (Synthetic) Chemistry of (May's), revised and rewritten by Dr G Malcolm Dyson, in consultation with Dr Percy May, fifth edition, *review* by F R Batchelor, 1597
Drugs (Tranquillizing) Effect of, on Survival from Experimental Diphtheric Intoxication (Prof Leo Greenberg and Dr James W Ingalls), 1721

rummond, the late Sir Jack, and Wilbraham, Anne The Englishman's Food, revised by Dorothy Hollingsworth, *review* by Dr Leslie J Harris, 484
Dry and Wet Conditions Effect of X-Radiation on the Survival of Yeast in (A Mookerjee), 1502
Dryden, Dr I G C Coal Science 412
Drying Survival of Spermatozoa following (Dr Harold T Meryman and Emanuel Kafig), 470
D'Silva, Prof J L Appointed to the Halliburton chair of physiology in King's College, London, 322, 405 , work of, 405
Du Bois, Dr P M Palaeomagnetism and Rotation of Newfoundland, B A 63
du Plessis, C Appointed director of the International Red Locust Control Service, 590 , work of, 590
du Pont Company of America Grant of 3,000 dollars to the University of Oxford, for the support of basic research in the field of theoretical chemistry, 1688, 1986
du Vigneaud, Prof Vincent (Bodanszky, Dr Miklos, and) A New Crystalline Salt of Oxytocin, 981, *erratum*, 1777
du Vigneaud, Prof Vincent (Katsoyannis, Panoyotis G , and) Active Principles of the Neurohypophysis of Cold-blooded Vertebrates—Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates, 1465
Dubach, P , and others Possible Role of Glycerol in the Winter-Hardiness of Insects, 288
Dubinin, Academician Mikhail M , and others Statement on Biological and Chemical Warfare, 1018
Dubiska, Anna, and others *Iso*-Antigens of Rabbit γ-Globulin, 1811
Dubiski, S , and others *Iso*-Antigens of Rabbit γ-Globulin, 1811
Dubos, Rene General Aspects of *Trypanosoma cruzi* Infection, 1115
Duck (A Chimaeric) with the Head of a Chick (Tamikazu Seno and Saburo Saito) B A 78
Duck Blood incubated *in vitro* Pathway of Carbon-^{14} Incorporation from NaH^{14}CO$_3$ to Heam in (A Breccia, A L Fantola, E Lazzarini and A Giustina), 1879
Duck Red Cells *in vitro* Role of Stroma in Haemoglobin Synthesis—Experiments on (A Breccia, A L Fantola, E Lazzarini and A Giustina), 1878
Ductile Molybdenum Impact (J A Belk) 897
Duddell Medal Address to the Physical Society (Prof L C Jackson), 954
Dudman, Dr W F Comparison of Slime from Tomato and Banana Strains of *Pseudomonas solanacearum*, 1969
Duff, Dr R S Appointed senior lecturer in medicine in the University of Sheffield, 410
Duffin, Dr W J (Goodyear, Dr J , and) Clay Minerals (Studies on Scarbroite), 780
Duhem, Prof Pierre Le Systeme du Monde—Histoire des Doctrines Cosmologiques de Platon a Copernic, Tome 10, *review* by Prof E J Dijksterhuis, 836
Dukelsky, V M Ionization Phenomena in Gases (Ionization of High-velocity Alkali Atoms by Collisions with Atoms of Inert Gases), 1354
Duncan, Dr A Local Races in Lugworms, *Arenicola marina* (L), 71
Duncan, C J Visual Illustration of University Lectures, 516
Duncan, Otis Dudley (edited by Philip M Hauser and) The Study of Population, *review* by Dr J Benjamin, 1521
Duncanson, L A , and others Structure of α-Hydroxyacetylene Complexes of Platinum(II), 526
Dunford, Nelson, and Schwartz, Jacob T Linear Operators, Part I, General Theory, *review* by Prof L S Goddard, 1763
Dungeness and the Nature Conservancy, 1533
Dungey, Dr J W Cosmic Electrodynamics, *review* by Prof V C A Ferraro, 1672
Dunham, Dr Bradford Self-Regulation in Living Systems (Modes of Operation of Digital Computers), 239
Dunham, Keith Account of the Workshops reconstructed in the Museum of Science and Industry at Birmingham, 1534
Dunn, E , and others New Pests of Cocoa (*Theobroma cacao* L) in Ghana following Applications of Insecticides, 2040
Dunn, G B (Meleka, A H , and) Fatigue-Induced After-Effect in Zinc Single Crystals, 896
Dunning, J E P Rocket Propulsion (The Application of Liquid Propellants to Rockets), 1265
Dunsmore Helen S Appointed a lecturer in chemistry at the University of Glasgow, 1915
Duprat, G At the Museum National d'Histoire Naturelle's celebration of the anniversaries of the 'Precurseurs et Fondateurs de l'Évolutionnisme—Buffon, Lamarck, Darwin', 860
Duration of Protective Action of Interferon against Infection with West Nile Virus (Dr Alick Isaacs and Marguerite A Westwood), 1232
Duration of the Regeneration Period of the Internal Reproductive Rhythm in a Xerophilous Equatorial Bird, *Quelea quelea* (H J de S Disney, B Lofts and Dr A J Marshall), 1659
Durbin, J Trends in Statistics Teaching, *review*, 1008
Durham, Prof Norman N , and Hubbard, Jerry S Antagonism of the Oxidative Assimilation of *p*-Aminobenzoic Acid by *p*-Aminosalicyclic Acid, 1398
Durie, Dr R A At the Second Australian Spectroscopy Conference (Weak Dipole Vibration Spectrum of Hydrogen Deuteride), 1197
Durie, Dr R A , and Szewczyk, J Coal Science (Spectroscopy of Coals—Light Spectroscopy), 413
Durif, S (Soule, J L , and) Coal Science (Ultra-fine Structure of Coals and Chars—Coals of Pores of Sizes 22-25A), 413
Durovic, Slavomil (Kupcik, Vladimir, and) Influence of the Size of the Halogen Atom on the Difference between Lattice Constants of Copper dipyridine dichloride and dibromide, 1060
Durrum, Emmett L , and others A Manual of Paper Chromatography and Paper Electrophoresis, second edition, *review* by Dr R Consden, 1436
Dust Concentrations (Asbestos) Measurement of, with the Long-Running Thermal Precipitator (Dr C G Addingley and Dr R Gaze), 715
Duthie, Dr E S *Obituary* by Charles H Lack, 589
Duthie, Dr E S (Haughton, G , and) Activation of Staphylococcal-free Coagulase by Purified Human Prothrombin, 116
Dutta, Prof A K , and others Propagation of Ultrasonic Waves in Liquids, 352
Dutta, Dr N L (Bradsher, Dr C K , and) Berberine Alkaloids via 6,7-Dimethoxy*iso*quinoline-1-aldoxime, 1943
Dutton, J , and others Ionization Phenomena in Gases, 1353
  Ionization Phenomena in Gases (Recent Measurements on the Growth of Pre-breakdown Ionization Currents for Air), 1354
Duval, X , and others Coal Science (Energy of Activation of the Combustion of Graphite), 414
Dux, Dr E International Starch Convention (1959), 513
Duysens, Dr L N M , and Amesz, J Energy Transfer with special reference to Biological Systems (Quantum Requirements of Diphosphopyridine Nucleotide in Photosynthesis), 690
Dworkin Prof M Function of Carotenoids in Photosynthetic Bacteria, 1891
Dwyer, L J and others Strontium-90 in the Australian Environment, 1957-58, 755
Dye, M H , and others Occurrence of 3-Indolylacetic and 3-Indolecarboxylic Acids in Tomato Crown-Gall Tissue Extracts, 825
Dye (Acridine) Aggregation of an, on Native and Denatured Deoxyribonucleates (Dr D F Bradley and Dr G Felsenfeld), 1920
Dyes 'Procinyl' (Imperial Chemical Industries, Ltd), 152
Dyes (Polar) Incorporation of N-Methyl Carbon of Monoethylaminoazobenzene into (Prof Hiroshi Terayama, Prof Morizo Ishidate and Akira Hanaki), 1460
Dyes (Systemic) A Rapid Method for Studying Tumour Blood Supply using (Dr R J Goldacre and Dr B Sylven), 63
Dyes (Textiles and), at the University of Leeds, 155
Dykes, P W Appointed lecturer in medical biochemistry and experimental pathology at the University of Birmingham, 1026
Dynamic and Static Deformation of Armco Iron (H P Tardif and P Chollet), 1917
Dynamics of Behavior (Prof Robert S Woodworth), *review* by Prof O L Zangwill, 1523
Dynamics of Proliferating Tissues (edited by Dorothy Price), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Dynamics (Gas) Fundamentals of (edited by Howard W Emmons), *review* by Prof J H Horlock, 1173
  Research in, *review* by Prof J H Horlock, 1173
Dyson, Sir George Museums and Finance, 598
Dyson, J An Image-Splitting Microscope for Accurate Measurement, 1561
Dyson, Dr N A Appointed lecturer in physics at the University of Birmingham, 684, 1362
Dystrophic Mice Prolonged Survival of, treated with 17α-Ethyl-19-Nortestosterone (Dr Robert M Dowben), 1966

E IONIZATION A Relation between Giant Travelling Disturbances and Sporadic (L H Heisler), 1788
Eades, R A New Techniques in the Analysis of Noise and Vibration, 415
Eales, Dr N B The Invertebrates, *review*, 573
Eames, A J Origin and Dispersal of Flowering Plants (Morphological Testimony for a Palaeozoic Origin), 1200
Eapen, J (George, Prof J C , and) Lipase Activity in the Brown and Yellow Adipose Tissue of the Bat, 59
Ear From Microphone to (G Slot), second edition, *review* by Prof Colin Cherry, 841
Ear of Barley Photosynthesis in the (Prof A Frey-Wyssling and Dr M S Buttrose), 2031
Earl, A G Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 858 , work of, 858
Early Cleavage of the Zebra Fish Variations in (A W Marrable), 1160
Early Distribution and Disappearance from the Blood of Promethium-147 in Rats Hormone Effects on (Dr Bergene Kawin), 1816
Early Induction of Flowering in Birch Seedlings (Dr K A Longman and Prof P F Wareing), 2037
Earth The—its Origin, History and Physical Constitution (Sir Harold Jeffreys), fourth edition, *review* by Prof B Gutenberg, 1007
Earth as Viewed in 1959, *review* by Prof B Gutenberg 1007
Earth-Current and Geomagnetic Disturbance Correlation between (V P Hessler and E M Wescott), 627
Earth Satellite 1959 θ (The Third Russian Space Rocket), 852
Earth's Magnetic Field Possible Reversals of the, in the Jurassic Period (Dr R W Girdler), 540
Earth's Mantle A Bore-Hole to the—AMSOC's Mohole (Gordon Lill and Willard Bascom), 140
Earth and Sky Matter, (Prof George Gamow), *review* by G R Noakes, 214
Earth (Rare) Metals Production of all the (Johnson, Matthey and Co , Ltd), 683
Earthquake Yellowstone Park (E Tillotson), 955
Earthquakes (Great) and the Astronomical Positions of Uranus (Prof A Tomaschek), 177
Earthworm Populations Estimating by using Formalin (Dr F Raw), 1661
Ease of Hydrolysis *in vitro* of Derivatives of 2-Aminofluorene Possible Relation between Carcinogenicity and (Prof Mary F Argus and Francis E Ray), 2018
East Africa Higher Education in (White Paper on), 243
  Report of the Working Party on Higher Education in (1958) 243
  Higher Education in (Work on the new Technical Institute), 1611
  Looking for Animals in (E H Tong), 1535
  Sea Fisheries Research in, 855
East Africa (Tropical) Flora of—Leguminosae subfamily Mimosoideae (J P M Brenan), 409
East African Marine Fisheries Research Organization Annual Report for 1958, 855
East African Waters (British) Black Marlin in (F Williams), B A 78
Easter School in Agricultural Science at the University of Nottingham School of Agriculture Sixth (The Measurement of Grassland Productivity), 154
Eating (Carrion-) by Ophiuroids (A K Nagabhushanam and J S Colman), 285
Eaton, S E , and Michaelis M Radiation in Industry, 506

Ebb and Flood Tide Discrimination between, in Migrating Elvers (*Anguilla vulgaris* Turt) by means of Olfactory Perception (F Creutzberg), 1961

Ebert, E Biological Effects of Low Doses of Ionizing Radiations, 1112

Ebert, G Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158

Ebertova, Dr Helena Redox Potentials in Soybean Nodules during the Vegetative Period, 1046

Eccles, Sir John Elected an Honorary Member of the American Academy of Arts and Sciences, 409

Eccles, Dr Rosamond M , and Westerman, Dr R A Enhanced Synaptic Function due to Excess Use, 460

Echinochrome A from the Spines of the Sea Urchin, *Diadema setosum* (Leske) Isolation of (Kokichi Nishibori), 1234

Echo-Location among *Collocalia* (Lord Medway), 1352

Echo Observations (Radio), of Venus (J V Evans and G N Taylor), 1358

Echoing Area (Radar), Polar Diagrams of Birds (J Edwards and E W Houghton), 1059

Eckerlin, Dr P (Rabenau, Dr A , and) Special Ceramics (A New Hexagonal Form of Be_3N_2), 1116

Eckersley, T L *Obituary* by G Millington, 149

Ecological Society, British Symposium on the Exploitation of Natural Animal Populations, 1451

Écologie et Biologie des Grands Mammiferes (Primates, Carnivores, Ongules), (Jacques Verschuren), (Exploration du Parc National de la Garamba, Mission H de Saeger, Fasc 9), 155

Ecology Practical Animal (W H Dowdeswell), *review* by Prof J B Cragg, 1262

  Quaternary (Linnean Society Symposium on), 1535

  Research Studentships for post-graduate training in (Nature Conservancy Awards for 1959), 156

Ecology of Acraniate Larvae (J H Wickstead and Quentin Bone) 1849

Ecology of the Freshwater Phytoplankton Buoyancy in relation to the (Dr J W G Lund), 1534

Ecology (Population) A Controversial Equation in (Dr A Milne), 1582 , (W B Yapp), 1582 , (Prof G C Varley), 1583

Ecology, International Society for Plant Geography and International Symposium on Mapping Vegetation, B A 23

Economic Developments in the Middle East, 1957-1958 (Supplement to World Economic Survey, 1958), (United Nations) 1280

Economic Growth Research and Development and (Dr A T Waterman), (United States National Science Foundation, Reviews of Data on Research and Development No 13), 591

Economic and Social Research, National Institute of The Structure of British Industry, a Symposium (edited by Duncan Burn), *review* by Prof A J Brown, 1089

Economics of Nuclear Power, including Administration and Law (edited by I R Maxwell, P W Mummery and Philip Sporn), Vol 2, *review* by R Brightman, 1673

Ectodermal Ridge Limb Development in the Absence of (Dr Eugene Bell, Dr John W Saunders, jun , and Dr Edgar Zwilling), 1736

Ectromelia Virus Transformations of Myxoma into Vaccinia or, in Tissue Culture (Hidesaburô Hanafusa, Teruko Hanafusa and Juntarô Kamahora), 1152

Eczema (Facial), of Sheep in the Field *Sporidesmium bakeri* and (R H Thornton and D P Sinclair), 1327

Edds, Jr , M V (edited by) Immunology and Development (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839

'Eddy' Diffusion in Chromatography (J Calvin Giddings), 357

Edels, H Thermonuclear Research, 1016

  Ionization Phenomena in Gases (Decay of Interrupted Arcs), 1355

Edge, N D , and others Congeners of Pempidine with High Ganglion-blocking Activity, 1707

Edholm, Dr O G Ergonomics, its Place in Industry, B A 21

Edinburgh, H R H The Duke of , To become the first Honorary Fellow of the Illuminating Engineering Society, 237

  New Ship Hydrodynamics Laboratory of the National Physical Laboratory opened by, 926

  Inauguration of *Merlin* at Aldermaston, 1191

Edington, J M Awarded a Nature Conservancy Research Studentship for post-graduate training in ecology (zoology), 156

Edmondson, B (Allen, N P , and) Atomic Mechanisms of Fracture (Necking down of Single Crystals of Iron), 325

Edmunds, Henry Appointed assistant agricultural and food a tache in Washington, B A 16

Edozien, Prof J C Blood Keto-Acids in Kwashiorkor, 1150

Education in 1958—being the Report of the Ministry of Education and Statistics for England and Wales, 571

Education A Career in, for University Graduates (Ministry of Education), revised edition, 1777

  Commonwealth—the United Kingdom Contribution (Duncan Crow), 592

  Handicapped Children in Britain—their Problems and (compiled by W A Axford), (Library Association), 1777

  Science, *review* by Dr W L Sumner, 923

Education, Ministry of Report of the Chief Medical Officer for 1956 and 1957 (The Health of the School Child—Fifty Years of the School Health Service), 98

  Education in 1958, 571

  A Career in Education for University Graduates, revised edition, 1777

Education Liaison Committee (British Commonwealth) Establishment of a, 1361

Education for the Age of Science (Report of the Science Advisory Committee to the President of the United States), 81, 87

Education in the New World, 81

Education of Technologists (Prof A J Murphy), 514

Education in the United States (1957-58), 418

Education (Adult), National Institute of After Work—Leisure and Learning in Two Towns (R Ruddock and Dr A Wilson), 1034

Education (Adult), Universities Council for Report for 1957-1958, 331

Education (Further), Yorkshire Council for, and others Symposium on Recent Developments in Textile Chemistry, 1845

Education (General), in a Modern Democracy, 1171

Education (Higher), in East Africa Report of the Working Party on (1958), 243

  White Paper on, 243

  Work on the new Technical Institute, 1611

Education (Higher), in Nigeria International Commission on Inaugural Meeting, 152

Education (Higher), in the U S S R , 504

Education (Public), in the United States of America Progress of (1957-58), 418

Education (Science) The Challenge of (edited by Joseph S Roucek), *review* by Dr W L Sumner, 923

Education (Secondary and Higher), in Britain, 1671

Education (Technical and Vocational), in the U S S R (M I Movšovič), 504

Education (Technological), in Britain, 94

Education (Technological) London and Home Counties Regional Advisory Council for Tenth Annual Report, 94

Education (University), in Britain Expansion of, 1431

Education (Veterinary) World Meeting on (Food and Agriculture Organization of the United Nations), 943

Educational Problems of the Commonwealth, 747

Educational Productions, Ltd Filmstrip No 5260, Insects in the Garden , Filmstrip CX 6290, Seed Germination , Filmstrip CX 6332, Grasses, Filmstrip CX 6208, Resident British Birds, 1777

Educational Research, No 3, 153

Educational and Training Facilities in Britain Expansion of, 569

Edvarson, K , and others Fractionation Phenomena in Nuclear Weapons Debris, 1771

Edwards, J , and Houghton, E W Radar Echoing Area Polar Diagrams of Birds, 1059

Edwards, Prof K C Trends in Urban Expansion (Presidential Address to Section E (Geography) of the British Association for the Advancement of Science), B A 43

Edwards, M , and others Electron Spin Resonance Investigations of *Allium cepa* and *Calliphora vomitoria*, 1402

Edwards, M V Conservation in the Scottish Highlands (Peat Afforestation), 1529

Edwards High Vacuum, Ltd Resignation of A S D Barratt from the Board 1451

Eel Migration (Dr J W Jones), 1281 , (Dr Denys W Tucker), 1281

Eels in Southern Africa (R A Jubb), 827

Eelworms in Strawberries Chemical Control of (R S Pitcher), 25

Effect of Acetylcholine on the Incorporation of Radiophosphorus into the Phosphatido-Peptide Fraction of Pancreas Slices (Prof C G Huggins), 1412

Effect of Acetylcholine and Eserine on the Spawning of *Hydractinia echinata* (M Yoshida), 1151

Effect of Added Substances on the Rate of Reductive Photo-bleaching (Reductive Photo-bleaching of Eosine), (Kengo Uchida, Shunji Kato and Masao Koizumi), 1620

Effect of Adrenalectomy on the Hormone Content of the Thymus in the Rat (Dr J Comsa), 279

Effect of 'Amino-Acid Imbalance' on Growth and Vitamin A Storage in the White Rat (M Rechcigl, jun , S Berger, J K Loosli and H H Williams), 1404

Effect of Atomic Tests on Radio Noise (C A Samson), 538

Effect of Bacillus Calmette-Guerin Infection on Transplanted Tumours in the Mouse (Dr Lloyd J Old, Dr Donald A Clarke and Dr Baruj Benacerraf), 291

Effect of Cell-Free Extracts from *Mycobacterium tuberculosis* $H_{37}Rv$ on Lung Succinooxidase (Dr A Bekierkunst and M Artman), 458

Effect of Chlorpromazine on Crocker Sarcoma and Ehrlich Ascites Carcinoma (Prof M Chorazy), 200

Effect of Chlorpromazine upon Isolated *d*-Amino-Acid Oxidase Systems (Dr Andrew Lasslo and Anne L Meyer), 1922

Effect of Cobaltic Oxide Pellets on the Vitamin B_{12} Content of Ewes' Milk (L I Hart and E D Andrews), 1242

Effect of Concentrated Urea Solutions on the Infectivity and Haemagglutinin of Vaccinia Virus (Prof J F McCrea and Jean O'Loughlin), 1497

Effect of Diet on the Blood Sugar and Liver Glycogen Level of Normal and Adrenalectomized Mice (B P Block and Dr G S Cox) 721

Effect of Dietary Fat and Extent of Blood Sampling on the Level of Plasma Cholesterol in the Rat (I Coleman and J M R Beveridge) 1041

Effect of Different Wild-Type Isoalleles on Crossing-over in *Drosophila melanogaster* (M M Green) 294

Effect of Dose Fractionation on the Incidence of Bone Tumours using Radioactive Phosphorus (Dr N M Blackett), 565

Effect upon Electrical Discharges Insulating Particles on Cathode Surfaces—their (L B Griffiths and P C L Pfeil), 1475

Effect of Emulsifiers and Organic Diluents in Soil Insecticide and Nematicide Formulations (F T Phillips), 1512

Effect of Ethylenediamine Tetra-acetate on Vitamin B_{12} Absorption in the Rat (Edward G Rice, Dr Samuel M Greenberg, John F Herndon and E J Van Loon), 1948

Effect of Flavins on Cramp caused by Phenol (Prof Kunio Yagi, Dr Hirofumi Yagi and Dr Ikuko Nagatsu), 1648

Effect of Gamma-Radiation on the Synthesis of Methanol over Zinc Oxide (T I Barry and R Roberts), 1061

Effect of Gibberellic Acid on the Initiation of Flowers and Runners in the Strawberry (P A Thompson and C G Guttridge), B A 72

Effect of Gibberellin on the Growth of Pollen Tubes (Nanda Bose), 1577

Effect on the Groundnut of Variations in Supply of Potassium, Calcium and Magnesium (Dr R Comber), 1003

Effect of Hybridization Changes on the Bond Energies of Carbon–Carbon Single Bonds (J E Bloor and S Gartside), 1313

Effect of Indole Acetic Acid and α-Naphthalene Acetic Acid on the Growth, Flowering and Fruit Set in Sweet Potato (G Satyanarayana and Dr G Rangaswami), B A 73

Effect of Insecticides on the Bodies of Nissl and Neurofibrillae of the Locust, *Schistocerca gregaria* (Dr Tohamy A Moussa and M Banhawy), 915

Effect of Iron and Zinc on Nucleic Acid and Protein Synthesis in *Mycobacterium smegmatis* (Frank Winder and Joan M Denneny), 742

Effect of Jet Aircraft Noise on Hearing (Surg -Lieut R R A Coles and J J Knight), 1803

Effect of the Level of Microbial Population on Isotopically Exchangeable Phosphate in Soil (Dr P Newbould and Dr R L Lucas), 1155
Effect of some Neuromuscular Blocking Agents on Mitochondrial Enzyme Systems (Dr J H Koch and Dr C H Gallagher), 1039
Effect of Nitrous Acid on Tobacco Mosaic Virus—Mutation or Selection? (F C Bawden), B A 27
Effect of Oxygen on Endogenous Metabolism of a Respiratory-deficient Brewer's Yeast (V E Chester), 1956
Effect of Oxygen Tension on Haem and Porphyrin Biosynthesis (J E Falk, R J Porra and Anne Brown, and F Moss and Helen E Larminie), 1217
Effect of Pempidine on the *in vitro* Synthesis of Acetylcholine (Joan Parkinson), 554
Effect of Photoperiod on the Gonadal Cycle in an Equatorial Bird, *Quelea quelea* (Dr Albert Wolfson and David P Winchester), 1658
Effect of Polycyclic Aromatic Hydrocarbons on the Polarographic Maximum of Copper (C E Searle), 1716
Effect of Polyphloretin Phosphate on the Suspension Stability of Red Blood Corpuscles (Dr Bengt Fries), 62
Effect of the Potassium Salt of Gibberellic Acid on the Growth and Reproduction Rate of *Paramecium multimicronucleatum* (A A Oravec, N G Strovilas, J L Beal and Arthur Tye), 1405
Effect of Proflavine on the Formation of the Virus of Foot-and-Mouth Disease and its Infective Ribonucleic Acid in Pig Kidney Tissue Culture Monolayers (F Brown and Doreen L Stewart), B A 74
Effect of Prolonged Thyroid Administration on Aged Male Rats (Prof John F Lhotka Lloyd Glenn McArthur and Arthur A Hellbaum), 1149
Effect of Protein Depletion on the Distribution of Protein Synthesis (Dr John Waterlow), 1875
Effect of Purine and Pyrimidine Analogues on Reversion of a Tryptophan-requiring Strain of *Escherichia coli* (C O Doudney and F L Haas) 114
Effect of Reduced Diphosphopyridine Nucleotide on the Swelling of Isolated Mitochondria (Dr G Di Sabato), *erratum*, 95
Effect of *Rhizobium* Polysaccharide on the Formation of Polygalacturonase in Lucerne and Clover (H Ljunggren and G Fahraeus) 1578
Effect of Selenium and Cystine on Lipide Peroxidation in Tissues Deficient in Vitamin E (Dr John G Bieri), 1148
Effect of Sexual Maturation and Castration on the Sex Chromatin Pattern in the Male Rat (St Zsifkovits, Ch Mehes and C Jobst), 1239
Effect of a Signal Contingent upon an Avoidance Response (Prof J D Keehn and Sanniyah Nakkash), 566
Effect of Sorbitol on the Urinary Excretion of some B Vitamins in Man (J D Watson and Prof John Yudkin), 911, *errata*, 1362
Effect of Steroids and related Compounds on the Growth of Dermatophytes (Dr F W Chattaway, J D Townsley and A J E Barlow), 1731
Effect of Sulphanilamide on Citric Acid Production by *Aspergillus niger* (K V Rajagopalan, R Radhakrishnamurthy and P S Sarma), 461
Effect of Sulphonamides on the Phagocytic Activity of the Reticulo-Endothelial System (Prof T Nicol and I A Sewell), 1241
Effect of Temperature on the Rate of Setting of Gypsum Plaster (M J Ridge), 47
Effect of Thioctic Acid on Gain in Body-Weight by Turkey Poults (J R Jowsey, R M Blakeley and H J MacGregor), 1323
Effect of Thiouracil and Thyroxine on Development and Growth of Cutaneous Melanoma in Killifish Hybrids (Prof A Stolk), 562
Effect of Tranquillizing Drugs on Survival from Experimental Diphtheric Intoxication (Prof Leo Greenberg and Dr James W Ingalls), 1721
Effect of Ultrasound on the Protein of Human Serum Denatured with Tannin (Dr Wizold Mizgalski and Irena Zygmunt), 1486
Effect of Ultra-Violet Irradiation on Transduction in *Pseudomonas aeruginosa* (J S Loutit), 1960
Effect of Vitamin D on the Respiration of Rat Oral Tissue (L Zar and Prof J T Irving), 1410
Effect of Whole-body X-Irradiation on the Insulin Resistance of Fasted Rats (Dr V Stankovic and N Sestan) 1816
Effect of X-Radiation on the Survival of Yeast in Dry and Wet Conditions (A Mookerjee) 1502
Effect (Acousto-Electric) Experiments on the (Piroska Smith (*née* Vermes) and D O Sproule), 264
Effect (Antidiuretic) of Vasopressin Mechanism of the (Dr Tsutomu Kashiwagi) 991
Effect (Chemical) of Ethylene during the Storage of Peas (Prof Frank A Lee), 462
Effect (Chemical) of Gene Mutation Human Haemoglobin *E*—the (Abnormal Human Haemoglobins), (Dr J A Hunt and Dr V M Ingram), 870
Effect (Curative) of Selenium upon the Incisor Teeth of Rats deficient in Vitamin E (Prof J T Irving), 645
Effect (Direct), of Erythropoeitin on Human Erythroid Cells *in vitro* Lack of (Edward L Alpen, L G Lajtha and Donald C Van Dyke), 1228
Effect (Inhibiting), of Iproniazid on the Depletion of Adrenal Catechol Amines induced by Reserpine Abolition by Chlorpromazine of the (F Camanni, Dr G M Molinatti and M Olivetti), B A 65
Effect (Inhibitory), of Fungistatic Antibiotics on the Production of Amylase by *Penicillium chrysogenum* (Dr I Horvath and A Szentirmai), 57
Effect (Peripheral), of the Bromide Ion on the Contraction of Striated Muscle (Dr D K de Jongh and H A Linnewiel), 1240
Effect (Promoting), of Urea on the *in vitro* Passive Sensitization of Isolated Plain Muscles with Precipitating Antibody (R Binaghi, Dr B N Halpern, P Liacopoulos and T Neveu), 1805
Effect (Protective), of Foreign Bone Marrow in Lethally X-Irradiated Mice Abrogation by Injected Mouse Blood of (L J Cole and R M Garver), 1815
Effect (Stimulatory), of Foreign Compounds on Ascorbic Acid Biosynthesis and on Drug-Metabolizing Enzymes (Dr A H Conney and Dr J J Burns), 363
Effect (Thomson) Influence of the, on the θ-φ Relationship for a Constrictive Resistance in Thermal Equilibrium (Dr W Davies), 975
Effective Increase in Nematode Populations by the Addition of Aureomycin (C O R Everard and William A Feder), 1887
Effective Viscosity Sedimentation and (Prof G J Kynch), 1311
Effects of Auxin and Gibberellic Acid on Growth of *Ulothrix* (Dr Herbert Conrad, Dr Paul Saltman and Dr Richard Eppley), 556
Effects of Carbon Tetrachloride on Kidney and Liver Function in the Sheep (Dr B P Setchell), 1242
Effects of Deuterium Oxide on the Synthesis of *T5* and *T7* Bacteriophages (E L Rothstein, L A Manson, R Hartzell, jun , and David Kritchevsky), 1167
Effects of 1,4-Dihydrazinophthalazine on Organ Content and Adrenal Medullary Secretion of Catechol Amines (M Bygdeman and L Stjärne), 1646
Effects of Elevated Plasma Sodium Concentration on Sodium and Potassium in the Erythrocyte of the Lizard *Trachysaurus rugosus* (Gray), (P J Bentley), 1403
Effects of the Energy of Strong Pulses of Ionic Current on Micro-organisms in Suspension (B S Gossling), 1881
Effects of Forest Areas on Water Resources, and the Technique of Lysimetry—Water and Woodlands (Dr L Leyton), 1184 , Lysimeters (F W Green), 1186
Effects of Gibberellic Acid on Juvenility in *Marsilea* and certain other Plants (Dr A Allsopp), 1575
Effects of Heating on X-Ray Diffraction by Carbons (Eitaro Matuyama), 544
Effects of Irradiation of Nerve on Muscular Response (A Portela, D Brandes, Prof G H Bourne, Marion Hines, P Stewart and B L Redd, jun), 734
Effects of Methylthiouracil or Thyroidectomy on Activation of Pituitary Acid Phosphatases *in vitro* by Whole Hypothalamic Extract (Dr V Schreiber and Dr V Kmentova), 728
Effects of Phenothiazine-Tranquillizers on Emotional and Motor Behaviour in Experimental Animals Differential Analysis of the (Dr M Taeschler and Dr A Cerletti), 823
Effects of Piston Mass and Bursting Pressure on the Motion of a Piston in a Hypersonic Gun Tunnel Measurement of the (B J Belcher), 1207
Effects of Printing Types and Formats on the Comprehension of Scientific Journals (E C Poulton), 1824
Effects of Reserpine on Secretion from the Denervated Adrenal Medulla (L Stjarne and S Schapiro), 2023
Effects of Substituted Phenoxy-Compounds and other Translocated Herbicides on the Rhizome of Bracken (Dr Elsie Conway and J A Forrest), 1416
Effects of 2-Substituted Thiadiazoles Reversal of, by Nicotinamide Analogues and Precursors (Dr Irwin H Krakoff, Corrine R Lacon and Dr David A Karnofsky), 1805
Effects of the Water Hyacinth (*Eichornia crassipes*) in the Nile Valley (H R J Davies), 1085
Effects (Biological) Incorporation of 5-Bromouracil into Transforming Principle of *Bacillus subtilis* and its (Dr Erela Ephrati-Elizur and Prof Stephen Zamenhof), 472
Effects (Biological), of Low Doses of Ionizing Radiations (Unesco, the International Atomic Energy Agency and the Comitato Nazionale per le Ricerche Nucleari Symposium on), 1111
Effects (Collision), in Atomic Spectra (W R Hindmarsh), 155
Effects (Combined), of Cortisone and Insulin on Developing Chicken Embryos (Dr Pietro de Franciscis and Prof Walter Landauer), 101
Effects (Comparative), of Heat on Chromatography and Ultra-violet Absorption of Deoxyribo- or Ribo-Nucleic Acids (Dr Saul Kit), 36
Effects (Field), on Chemisorbed Films in Electron Emission Microscopy (R J Hill and P W M Jacobs), 895
Effects (Genetical), of Population Subdivision (P A P Moran), 505
Effects (Geophysical), of High-Altitude Nuclear Explosions (W A Feibelman), 442
Effects (Hormone), on Early Distribution and Disappearance from the Blood of Promethium-147 in Rats (Dr Bergene Kawin), 1816
Effects (Immediate and Low-level), of Ionizing Radiations (Dr Tikvah Alper), 1111
Effects (Insecticidal), of Activated Charcoal and Clays (S K Majumder, K S Narasimhan and V Subrahmanyan), 1165
Effects (Magnetic), resulting from Two High-Altitude Nuclear Explosions (J A Lawrie, V B Gerard and P J Gill), B A 34
Effects (Pathophysiological), of Circulating Ferritin (Yoshio Oki), 1944
Effects (Pharmacological), of Staphylolysin on the Isolated Rat Uterus Some (Dr B Wiegershausen), 2017
Effects (Polarization and Resolving Time), in Photon Correlation (Dr E Brannen and Prof W Wehlau), 263
Effects (Prophylactic), of Amine Oxides in Radiation Injury in Mice (Dr Thomas J Haley, Dr Anna M Flesher and Dr Nathan Komesu), 198
Effects (Solar), in the Motion of *Vanguard* (Dr Stanley P Wyatt), 351
Effects (Spermicidal), of Dioctyl Sodium Sulphosuccinate Registration of the (Prof Per Eric Lindahl and Kjell Wedin), 1289
Effects (Steric), in Conjugated Systems—Proceedings of a Symposium held at the University, Hull, 1958, by the Chemical Society (edited by Dr G W Gray), *review* by Dr G Eglinton 1522
Effects (Steric), in Organic Molecules, *review* by Dr G Eglinton, 1522
Effects (Structural), of Kinetic Heating (Royal Aeronautical Society Discussion on), 30
Efficiency of the Mitochondrial Oxidative Phosphorylations in Intact Ascites Tumour Cells (Dr P Emmelot and C J Bos), 2024
Efficiency (Lowered Bactericidal), of Hydrogen Peroxide on Milk from Cows treated with Penicillin (J Babad, D L Boros and F Baier), 292
Efficiency and Separating Power of Packed and Capillary Gas Chromatographic Columns Comparison of (Dr J H Purnell), 2009
Efficient Communication of Skills New Developments in Training—Five Studies in the (edited by Frank A Heller), 421
Efficient Use of Man-power in Industry (Report of an inquiry by the National Joint Advisory Council), 25
Efford, Ian Rediscovery of *Bathynella chappuisi* Delachaux in Britain, 558
Egami, Prof Fugio, and others Formation of Streptolysin *S* by Streptococcal Protoplasts, 832
Egerton, Sir Alfred *Obituary* by Dr A G Gaydon, 678
Egg (Sea Urchin) An Inhibitor of Cytochrome Oxidase Activity in the (Rachele Maggio and Alberto Monroy), 68
Egg Laying in Tingidae (Hemiptera) Mode of (T S Thontadarya and G P Channa Basavanna), 289
Egg-White Allergy in the Rat Influence of the Thymus upon the (J Comsa), 1726
Eggeling, W J Conservation in the Scottish Highlands (The Effect of Conservation Practices on Animal Distribution), 1529
Eggs Differentiation between a Growth-Promoting Factor and a Tumour-Susceptibility Factor in (Charles H Hill and Henry W Garren), 824

INDEX

Eggs of *Drosophila* and other Flies Plastron Respiration in the (Dr H E Hinton), 280
Eggs of the Polypodiaceous Ferns Deoxyribonucleic Acid in (Dr P R Bell), 1664
Eggs (Embryonated), and Unsusceptible Cell Lines Infectivity of Polio Virus Ribonucleic Acid for (P De Somer, Dr A Prinzie and E Schonne), 652
Eggs (Giant), of the Clover Cyst Nematode, *Heterodera trifolii* Goffart, 1932 (Roland H Mulvey), 1662
Eggs (Grasshopper), kept for Long Periods in Mineral Oil Survival of (Prof Eleanor H Slifer), 1424
Eggs (Mouse) Experiments on the Development of Isolated Blastomeres of (Dr Andrzej K Tarkowski), 1286
Eggs (Prediapause), of *Aedes* Mosquitoes Control of Hatching in the (Dr J D Gillett), 1621
Eggvin, Dr J Polar Front Survey (Hydrography—Temperature Salinity and Current Charts for the Norwegian and Greenland Seas), 1181
Eglinton, Dr G Steric Effects in Organic Molecules, *review*, 1522
  Use of Isotopes in Organic Syntheses, *review*, 1830
Egypt *In vitro* Study of the Anthelminthic Property of *Artemesia monosperma* grown in (A Sharaf, Z F Ahmed and F Abdel Moneim), 647
Egypt and Greece in Medical History, *review* by Dr Douglas Guthrie, 662
Egyptian and Cnidian Medicine Ancient (Robert O Steuer and J B de C M Saunders), *review* by Dr Douglas Guthrie, 662
Ehretsmann, J H, and Seymour, R C Coal Science (Gaseous Products and Thermochemistry of the Formation and Decomposition of Surface Oxides on Charcoals), 414
Ehrlich Ascites Carcinoma Effect of Chlorpromazine on Crocker Sarcoma and (Prof M Chorazy), 200
Ehrlich Ascites Tumour Ribonucleases of Mouse Tissues and of the (K A O Ellem, J S Colter and Jeanne Kuhn) 984
Ehrlich's Reagent Colour Reactions of certain Phenols with (Dr Cornelius Steelink), 720
Eichornia crassipes (Water Hyacinth) Effects of the, in the Nile Valley (H R J Davies), 1085
Eigen, Dr M East Chemical Reactions in Solution (Relaxation Methods), 1453
Eighteenth Century Chemistry in the (Dr Andrew Kent), 1452
Eighteenth Century Bird Paintings in the Library of Sir Joseph Banks (1743-1820) Some (Averil Lysaght), 941
Eimeria tenella Protein Synthesis in Macrophages containing (Dr G A Gresham and J G Cruickshank), 1153
Einarsson, Dr H Polar Front Survey (Biology—Zooplankton collected with Hardy Indicators in the Irminger Sea), 1183
Eire Agricultural Research in—An Foras Taluntais (The Agricultural Institute), 28
  Appointment of Dr T Walsh as director, 29
  Appointment of Dr L B O'Moore as chief of the Animal Production Division, 29
  Appointment of J J Byrne as chief of the Rural Economy Division, 29
Ekert, B, and Monier R Structure of Thymine Hydroperoxide produced by X-Irradiation, B A 58
Elasmobranch *Raja clavata* A Functional Interpretation of the Electron-Microscopic Structure of the Sensory Hairs in the Cristae of the, in Terms of Directional Sensitivity (Prof O Lowenstein and J Wersall), 1807
Elastin Some Improvements in Colorimetric Determination of (Dr V Scarselli), 1563
Electric Arc in Welding (Third 'Joining of Metals' Conference at the University of Birmingham,) 1030
Electric Field (Crystalline), in Cobalt Acetate Tetrahydrate Temperature Variation of the Principal Magnetic Moments of Co^{++} Ions and the Asymmetry of the (Dr Bhagawati Charan Guha), 50
Electrical Activity in the Muscle Cells of *Ascaris lumbricoides* (Dr M Jarman), 1244
Electrical Determination of Transport of 3-Indole Acetic Acid in *Avena* (I A Newman), 1728
Electrical Discharges Insulating Particles on Cathode Surfaces—their Effect upon (L B Griffiths and P C L Pfeil), 1475
Electrical Discharges (Cosmical) The Temperature required for Nuclear Reactions in (Dr C E R Bruce), 2004
Electrical Engineering Modern Network Theory in (University of Birmingham Conference on), 1691
Electrical Engineering at Newcastle-upon-Tyne, 404
Electrical Engineering at Southampton, 590
Electrical Engineering in the University of Western Australia, 93
Electrical Engineers, Institution of Election of Officers, B A 16
  Christmas Holiday Lecture, Colour Television (G G Gouriet), 1535
Electrical Engineers, Institution of, and the British Nuclear Energy Conference Convention on Thermonuclear Processes, 240
Electrical Engineers, Institution of (Electronics and Communications Section) International Convention on Transistors and Associated Semiconductor Devices, 693
  International Transistor Exhibition, 693
Electrical Engineers, Institution of (Electronics and Communications Section), and the International Federation for Medical Electronics Third International Conference on Medical Electronics, 1535
Electrical Research Association Thirty-eighth Annual Report (1958), 1538
Electrical Resistivity Changes observed in a Semiconducting Diamond after Heat Treatment (R E Mutch and Dr F A Raal), 1857
Electrical and Allied Industries Research Association, British (Prof J Greig), 1538
Electricity Basic—a Course of Training developed for the United States Navy by Van Valkenburgh, Nooger and Neville, Inc , adapted to British and Commonwealth Usage by a special Electronics Training Investigation Team of the Royal Electrical and Mechanical Engineers, *review* by G R Noakes, 133
Electricity Generating Board, Central Grant of £3,860 to the University of Leeds, for research on the utilization of pulverized fuel ash, 1534
Electrode (Dropping Mercury) Reduction of the $Fe_2SO_3^+$ Ion at the (F M Page), 1481
Electrode (Mercury) Influence of Gold in a, on certain Electrode Processes (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus), B A 56
  Influence of Platinum in Mercury on the Mechanism of Electrode Reactions at the (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus), 1795
Electrode (Oxygen) A Rapid and Sensitive Method for the Determination of Xanthine Oxidase Activity using the (Metry Bacila and Dr Gilberto G Villela), 1394
Electrode Processes Influence of Gold in a Mercury Electrode on certain (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus), B A 56
Electrode Reactions at the Mercury Electrode Influence of Platinum in Mercury on the Mechanism of (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus), 1795
Electrodes Luminous Spots on, in Insulating Oil Gaps (T W Dakin and Daniel Berg), 120
Electrodes (Glass) Alkali Ion Determinations by means of (Research Symposium at the University of Sheffield), 1616
Electrodes (Glass Micro-), for Measuring Intracellular Activities of Sodium and Potassium (Dr J A M Hinke), 1257
Electrodynamics Cosmic (Dr J W Dungey), *review* by Prof V C A Ferraro, 1672
Electrodynamics (Quantum) Experimental Tests of (Prof W E Lamb), 954
Electrolysis Hydrogenolysis of Carbon-Oxygen Bonds in some Aromatic Compounds by (Dr P H Given and Dr M E Peover), 1064
  Principles of (Prof C W Davies), *review* by Dr V Gold, 1902
Electron Bombardment Heating by (A Calverley) 690
Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Services Electronics Research Laboratory Symposium on), 690
Electron Bombardment Techniques Electron Bombardment Floating-zone Melting and allied (Services Electronics Laboratory Symposium on), 690
Electron Density-Height Profiles Conversion of Ionospheric Virtual Height-Frequency Curves to (Dr J O Thomas and M D Vickers), (Radio Research Board, Special Report No 28), 1024
Electron Diffraction Pattern (Single-Crystal) Structure of Precipitated Cadmium Sulphide as studied by (Dr Ryoitiro Sato), 2005
Electron Emission Microscopy Field Effects on Chemisorbed Films in (R J Hill and P W M Jacobs), 895
Electron Impact Isomerization to the Tropylium Ion induced by, and its Significance (Dr W Hanuš) 1796
Electron Mass Ratio of Nucleon Mass and (Prof A J Rutgers), 894
Electron Microscope Wall-chart of the Metro-Vickers *EM6* (Metropolitan-Vickers Electrical Co Ltd), 237
Electron-Microscopic Structure of the Sensory Hairs in the Cristae of the Elasmobranch *Raja clavata* A Functional Interpretation of the, in Terms of Directional Sensitivity (Prof O Lowenstein and J Wersall), 1807
Electron-Microscopic Study of Spores of Morphological Variants of *Streptomyces erythreus* Strains (L Dolezilova, Z Vanek and A Kralik), 1888
Electron Microscopical Structure of the Wall of Small Blood Vessels in Human Multiform Glioblastoma (Dr S H M Nystrom), 65
Electron Microscopy An Embedding Resin Miscible with Water for (Dr I R Gibbons), 375
  The Shape of Protein Molecules suggested by (Dr R C Valentine), 1838
Electron Microscopy of Autoradiographed Radioactive Particles (L A George, II, and G S Vogt), 1474
Electron Microscopy of Viruses Recent Work on the (Dr Kenneth M Smith), 1440
Electron Paramagnetic Resonance at 4 2°K of γ-Irradiated Polymethyl Methacrylate and Polymethacrylic Acid (Dr Derick W Ovenall), 181
Electron–Phonon Interaction in Solids (Physical Society Conference on), 1613
Electron Physics Advances in Electronics and (edited by L Marton, assisted by Claire Marton) Vol 10, *review* by J R Tillman, 1601
Electron Physics and Technology (Dr J Thomson and E B Callick), *review* by Dr D A Bell, 83
Electron Spin Resonance Free Radicals as Studied by (Dr D J E Ingram), *review* by Dr T M Sugden, 1259
  Free Radicals in X-Rayed Seeds of High and Low Water Content, as Measured by (Dr W Klingmuller, Dr G R Lane, M C Saxena and Dr D J E Ingram), 464
Electron Spin Resonance Investigations of *Allium cepa* and *Calliphora vomitoria* (M Edwards, Dr G A Kerkut, K A Munday, Dr D J E Ingram, M C Saxena and K Leach), 1402
Electron Spin Resonance and Divalency of some Dithiocarbamates of the Coinage Metals (Cu Ag Au), (Tore Vanngard and Stig Åkerstrom), 183
Electron Technology, *review* by Dr D A Bell, 83
Electron, Proton and Neutron A Comparison of the Charges of the (A M Hillas and T E Cranshaw), 892 , (Prof H Dondi and Dr R A Lyttleton), 974
Electronegativity of the Adjacent Atoms in some Aliphatic Carbonyl Compounds A Correlation between the Shift in the Ultra-Violet Absorption Maxima and the (Dr P Borrell), 1932
Electronic Achievements British 943
Electronic Apparatus for Biological Research (P E K Donaldson), *review* by W J Perkins, B A 4
Electronic Computer Experimental Music—Composition with an (Prof L A Hiller, Jr , and Leonard M Isaacson), *review* by Prof E G Richardson, 1754
Electronic Computers Music and, *review* by Prof E G Richardson, 1754
Electronic Engineering Association (Radio Industry Council and the) Premiums for articles on Electronics, 943
Electronic Excitation Transfer Mechanisms of (Prof Th Forster), 688
Electronic Prediction of Swarming in Bees (E F Woods), 842
Electronics Introductory *review* by Prof D G Tucker, 751
  Junction Transistor (Richard B Hurley), *review* by J W R Griffiths, 838
  Medical (Electronics and Communications Section of the Institution of Electrical Engineers and the International Federation for Medical Electronics Third International Conference on), 1535
  Premiums for articles on (Radio Industry Council and the Electronic Engineering Association), 943
  Principles of (Prof M R Gavin and Dr J E Houldin) *review* by Prof D G Tucker, 751
  Sixth National Symposium on Reliability and Quality Control in, 1362
  Transistor, *review* by J W R Griffiths, 838
  Transistor (Arthur W Lo Richard O Endres, Jakob Zawels, Fred D Waldhauer and Chung-Chih Cheng), *review* by J W R Griffiths, 838

Electronics, Institution of (Northern Division) Fourteenth Exhibition of Electronic Devices, 1277
Electronics (Medical) Bibliography of (prepared by the Medical Electronics Center of the Rockefeller Institute), 1026
Electronics (Medical), International Federation for (Electronics and Communications Section of the Institution of Electrical Engineers and the) Third International Conference on Medical Electronics, 1535
Electronics in Biology, *review* by W J Perkins, B A 4
Electronics Exhibition (V H Attree), 1277
Electronics Research Laboratory (Services) Symposium on Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques, 690
Electronics and Electron Physics Advances in (edited by L Marton assisted by Claire Marton), Vol 10, *review* by J R Tillman, 1601
Electrophoresis—Theory, Methods and Applications (edited by Milan Bier) *review* by Dr R Consden, 84
  The Principles of (René Audubert and Serge de Mende), translated by A J Pomerans, *review* by Dr R Consden, 84
Electrophoresis in Theory and Practice, *review* by Dr R Consden, 84
Electrophoresis of Human Gastric Juice (Dr Ragnhild Gullberg and Dr Borje Olhagen), 1848
Electrophoresis (Agar), of Normal Soluble Proteins in Guinea Pig Liver (Prof Iv Goranov, Y Todorov, X Skatshokova, M Hlebarova and P Kuzmanova), B A 64
Electrophoresis' ('Crossing-Paper) Proof of the Formation of Enzyme-Substrate Complex by (Prof S Nakamura, K Takeo, I Sasaki and M Murata), 638
Electrophoresis (High-Voltage Paper) of Aliphatic Amines and related Compounds (Dr D Gross), 1633
Electrophoresis (Paper) A Manual of Paper Chromatography and (Richard J Block, Emmett L Durrum and Gunter Zweig), second edition *review* by Dr R Consden, 1436
Electrophoresis (Paper), of Hippopotamus Haemoglobin (D H L Rollinson and G D Lomax), 1653
Electrophoresis (Paper), of Trypanosomal Extracts (Dr Robert S Desowitz), 986
Electrophoresis (Starch-Gel) Separation of Fast-Moving γ-Globulins by (Dr M D Poulik, Dr W W Zuelzer and Dr R Meyer), 1800
  Separation of Prealbumins by (Dr M D Poulik), 1067
Electrophoresis (Starch-Gel), of Seminal Plasma, Serum and Bile Visualization of Acid and Alkaline Phosphatase after (Dr Bengt Estborn), 1636
Electrophoresis (Two-Dimensional High-Voltage Paper), of Amino- and other Organic Acids (Dr D Gross), 1298
Electrophoresis and related Methods (Chromatography,) Chromatographic Reviews—Progress in (edited by Michael Lederer), Vol I *review* by Dr R Consden, 1436
Electrophoretic Heterogeneity of Trypsin (J C Perrone, L V Disitzer and A Iachan) 1225
Electrophoretic Mobility and Colourability of Substituted Human Serum Proteins Modifications in Immunological Behaviour, (M Steinbuch Dr J M Fine and A Battistini), 1571
Electrophoretic Patterns (Paper), obtained by Paraffin-Oil Fixation (H Waldmann-Meyer), 1567
Electrophoretic Patterns (Starch Gel) Localization of Haemocyanin on (J R Whittaker), 193
Electrophoretic Zones in Agar Gel Direct Spectroscopic Examination of (Dr G H Beaven and W B Gratzer), 359
Elektronenmikroskopie, Deutschen Gesellschaft fur Conference, 508
Element 102 (Nobelium) Research on (P R Fields *et al*), 507
Elementary Bodies Psittacosis (F L Constable), 473
Elementary Particles The Physics of (Prof J D Jackson), *review* by P T Matthews, 1677
Elements Heavier, *review* by Dr J K Dawson, 922
  Periodic Classification of (A A Clifford), 2012
  The Transuranium (Prof Glenn T Seaborg), *review* by Dr J K Dawson, 922
Elements of Engineering Statics (Prof H Deresiewicz), *review* by T M Charlton, 1674
Elements (Structural), of the Bacterial Cell Affinity of Lysozyme to, as studied with Enzyme Labelled with Radioactive Iodine (Prof C Weibull, B Zacharias and H Beckman), 1744
Elements (Trace), in Basic Magma Deposition of (R J P Williams), 44
Elements (Trace), in Marine Biological Ashes Some Activation Analyses of Six (R Fukai and Prof W W Meinke), 815
Elements other than Carbon Substitution at (Sir Christopher Ingold), *review* by Dr R I Reed, 1262
Eleusine indica (L) Gaertn Vivipary in (H T Clifford), 1888
Elevated Plasma Sodium Concentration Effects of, on Sodium and Potassium in the Erythrocyte of the Lizard *Trachysaurus rugosus* (Gray), (P J Bentley), 1403
Eley, Prof D D (Cardew, M H , and) Energy Transfer with special reference to Biological Systems (Measurements on the Semiconductivity of Amino-acids, Haemoglobin and Globin), 689
Eley, Prof D D , and others (edited by) Advances in Catalysis and related Subjects Vol 10 *review* by Dr F S Stone, 1974
Elgaroy, Oystein Observations of the Fine Structure of Enhanced Solar Radio Radiation with a Narrow-Band Spectrum Analyser, 887
Elias, H -G Macromolecules (Practice of using Membranes partially Permeable to the Solute), 1689
Eliezer, Prof C J Appointed to the chair of mathematics in the University of Malaya in Kuala Lumpur, 307 , work of, 307
Elkind, M M , and Sutton, Harriet X-Ray Damage and Recovery in Mammalian Cells in Culture, 1293
Ellefsen, Ø Macromolecules (Preparation of a New Crystalline Modification of Cellulose), 1690
Ellem, Dr Kay The Structure of Science (Viral Nucleic Acids), B A 9
Ellem, Dr Kay, and others Ribonucleases of Mouse Tissues and of the Ehrlich Ascites Tumour, 984
Elliot, W H (Coleman, G , and) Structure and Chemistry of Proteins (Synthesis of α-Amylase by *Bacillus subtilis*), 1277
Elliott, L E , and others Gas Chromatographic Separation of Long-chain Fatty Acid Methyl Esters on Polyvinyl Acetate, 1710
Elliott, Paul R , and others Oxygen Uptake of Glycerol-extracted Muscle Fibres, 1947
Elliott, Dr S D Group and Type-specific Polysaccharides of Group *D* Streptococci, 1342
Ellis, Dr D V The Benthos of Soft Sea-bottom in Arctic North America, B A 79
Ellis, G R A , and Cartwright, D G Directional Observations of Radio Noise from the Outer Atmosphere, 1307
Ellis, G R A , and others Spaced Observations of Radio Noise from the Outer Atmosphere, 1391
Ellis, Dr J R , and Burton, M A Sterility in *Lathyrus odoratus* L , 204
Ellis, M J , and others A Haemoglobin with Unusual Alkaline-denaturation Properties in a Turkish-Cypriot Woman, 1876
Ellis, R B , and Hawthorne, J N 1-Glyceryl-2-*myo*-inositol Phosphate—Alternative Synthesis and Behaviour on Hydrolysis (Synthesis and Properties of 1-Glyceryl-2-*myo*-inositol Phosphate), 790
Elmes, Dr P (White Dr J C , and) Flow Properties of Biological Systems (Viscosity, Intrinsic Viscosity and Thixotropy Measurements on Dilute Bronchial Mucoid Sputum), 1540
Elmqvist, Dr A , and others Gel Filtration as a Method for Purification of Protein-bound Peptides exemplified by Oxytocin and Vasopressin, 1565
Elodi, P , and Szabolcsi, G Role of the Co-enzyme in the Stabilization of Glyceraldehyde-3-phosphate Dehydrogenase, 56
Eloranta, J (Linschitz, H , and) Fast Chemical Reactions in Solution (Flash Photolysis to Study Metal and Hydrocarbon Ion Solutions), 1453
Elsden, Dr S R Appointed to the chair of microbiology in the University of Sheffield, 234 , work of, 234
Elton, Dr G A H (Collison, Dr R , and) Gelation (The Swelling of Starch), 863
Elution of Lipids from Silicic Acid A Concave Concentration Gradient of Ethanol in Chloroform employed in (J J Wren), 816
Elvers (Migrating), *Anguilla vulgaris* Turt Discrimination between Ebb and Flood Tide in, by means of Olfactory Perception (F Creutzberg), 1961
Emanuel, Prof N M Oxidation of Organic Compounds (Oxidation of Inorganic and Organic Compounds by Permanganate), 327 , (Slow Branched-chain Oxidation Reactions of Hydrocarbons), 327
Embassy (United States), in India Appointment of Prof E C Watson as scientific attache to the, 1686
Embedding Resin Miscible with Water for Electron Microscopy (Dr I R Gibbons), 375
Embryo Sac-like Structures in the Microsporangia of *Leptomeria billardierii* R Br Occurrence of (Dr Manasi Ram), 914
Embryo (Chick) Inhibition of Skeletal Formation in the, following Administration of Tetracycline (Gerrit Bevelander, Hiroshi Nakahara and Gloria K Rolle), 728
Embryology *review* by Sir Julian Huxley, 1176
Embroylogy A History of (Dr Joseph Needham), second edition, *review* by Sir Julian Huxley, 1176
Emmons, Howard W (edited by) Fundamentals of Gas Dynamics, *review* by Prof J H Horlock, 1173
Embryonated Eggs and Unsusceptible Cell Lines Infectivity of Polio Virus Ribonucleic Acid for (P De Somer, Dr A Prinzie and E Schonne), 652
Embryonic Nutrition (edited by Dorothea Rudnick), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Embryos of Germinating Wheat Isolation and Purification of Nitrate Reductase from (D Spencer), 682
Embryos (Chick), injected with Adult Chicken Blood Cytological Identification of Proliferating Donor Cells in (P M Briggs and L N Payne), 1594
Embryos (Chicken) Combined Effects of Cortisone and Insulin on Developing (Dr Pietro de Franciscis and Prof Walter Landauer), 101
Embryos (Pea and Wheat) Fine Structure in Cells of (G Setterfield, H Stern and F B Johnston), 505
Embryos (Plant) A Quick Method for Extracting, from certain Types of Seed (M D Gwynne), 1588
Emeleus, H J and Sharpe, A G (edited by) Advances in Inorganic Chemistry and Radiochemistry, Vol I, *review* by Dr D W A Sharp, 1756
Emery, Dr T , and Neilands, Dr J B The Iron-Binding Centre of Ferrichrome Compounds, 1632
Emery, Dr V J Nuclear Forces and the Few-Nucleon Problem (Calculations of the Binding Energies of Nuclei using the Brueckner Method), 1114
Emetic Material Production of, by Species of *Fusarium* (Neville Prentice, A D Dickson and Prof J G Dickson), 1319
Emission of Relatively High-Energy Ions from Low-Voltage Arcs (E R Harrison), 245
Emission (Smoke), from Coal and Low-Temperature Chars (Studies of Coal), (D Finch), 426
Emission Microscopy (Electron) Field Effects on Chemisorbed Films in (R J Hill and P W M Jacobs), 895
Emissions caused by Solar Flares Rocket Studies of (United States National Science Foundation Grant), 406
α-Emitting Nuclides in Biological Material Spectroscopic Identification of (Prof W V Mayneord and C R Hill), 667
Emmelot, Dr P , and Bos, C J Efficiency of the Mitochondrial Oxidative Phosphorylations in Intact Ascites Tumour Cells, 2024
Emmett, Prof Paul H (edited by) Catalysis, Vol 5, Hydrogenation, Oxo-Synthesis, Hydrocracking, Hydrodesulphurization, Hydrogen Isotope Exchange and related Catalytic Reactions, *review* by Dr E B Maxted, 750 , Vol 6, Alkylation, Isomerization, Polymerization, Cracking and Hydroreforming, *review* by G R Noakes, 1090
Emotional and Motor Behaviour in Experimental Animals Differential Analysis of the Effects of Phenothiazine-Tranquillizers on (Dr M Taeschler and Dr A Cerletti), 823
Emson, H E (Stich, H F , and) Aneuploid Deoxyribonucleic Acid Content of Human Carcinomas, 290
Emulsifiers and Organic Diluents Effect of, in Soil Insecticide and Nematicide Formulations (F T Phillips), 1512
Emulsions (Lipid) Lymphoid Necrosis Induced by (Dr A A Shivas and Dr G P Fraser), 1813

Encephalitis Virus (Tick-borne) Infectious Ribonucleic Acid from Mouse Brains infected with (F Sokol, H Libikova and J Zemla), 1581
Encephalographic Frequency Range Subjective Light Pattern Spectroscopy in the (Prof M Knoll and J Kugler), 1823
Encephalomyelitis (Experimental 'Allergic') Various Types of Acquired Resistance to (G J Svet-Moldavsky, I A Svet-Moldavskaya and L I Raffkina), 1552
Enchytraeidae (Olig) A Sexual Reproduction in the (B Christensen), 1159
Encyclopaedia Large Soviet (Bolshaya Sovietskaya Enziclopediya), Vol 50, 857, 1451
Endocrine Actions (Anti-Atherogenic and) The C_{17}-OH Group of Œstradiol—Relationships between its (Dr Manuel Rene Malinow, Alvaro L Gimeno, Amanda A Pellegrino-Iraldi, Martha A Fernandez-Gimeno, Jorge L Lacuara and Jaime A Moguilevsky), 1720
Endocrine Control in Crustaceans (Dr David B Carlisle and Sir Francis Knowles), *review* by Prof J H Welsh, 1760
Endocrinology of Reproduction (edited by Prof Joseph Thomas Ve ardo), *review* by Dr T Mann, 1434
Endogenous Metabolism of a Respiratory-deficient Brewer's Yeast Effect of Oxygen on (V E Chester), 1956
Endogenous Rhythms of Body Temperature in Hibernating Bats (Prof Michael Menaker), 1251
Endopolyploidy in the Meristem of Onion Roots Nuclear Deoxyribonucleic Acid Content and (D Srinivasachar), B A 80
Endothelial Cells (Damaged) Some Properties of (Dr J R O'Brien), 1580
Endotoxins Interaction of Erythrocytes and (V Bokkenheuser and H J Koornhof), 109
Endres, Richard O , and others Transistor Electronics, *review* by J W R Griffiths, 838
Energies (Bond), of Carbon–Carbon Single Bonds Effect of Hybridization Changes on the (J E Bloor and S Gartside), 1313
Energy of Strong Pulses of Ionic Current Effects of the, on Micro-organisms in Suspension (B S Gossling), 1881
Energy (Chemical) Conversion of Light into, in Photosynthesis (Prof Daniel I Arnon), 10, *errata*, 1613
Energy (Free), of Hydrolysis of Adenosine Triphosphate Equilibrium Constant of the Galactokinase Reaction and (Dr M R Atkinson, Eleanor Johnson and Prof R K Morton), 1925
Energy (High-) Ions Emission of Relatively, from Low-Voltage Arcs (E R Harrison), 245
Energy (High) Radiation Estimation of Chain Fracture and Cross-Linking of Rubber by (P Hayden), 1865
Energy (Interchange), for Binary Systems Estimation of the, from Mutual Solubility Data (Kiyoharu Ishida), 814
Energy (Low-) Particle Tracks Bubble Counting on (I R Birss), 1474
Energy (Solar) Transactions of the International Conference on the Use of—The Scientific Basis (Tucson 1955), Vol I, The Available Energy, Measurement of Radiation , Vol 2, Thermal Processes, Part I, Section A, Flat Plate Collectors , Vol 2, Thermal Processes, Part I, Section B, High-Temperature Solar Furnaces, Solar Power , Vol 3, Thermal Processes, Part 2, Solar House Heating, Solar Water Heating, Solar Stoves, Solar Distillation , Vol 4, Photochemical Processes , Vol 5, Electrical Processes, *review* by Dr H Heywood, 217
Energy Spectrum Changes (Cosmic Ray) Evidence for, during a Forbush Decrease (K W Ogilvie and M M Winn), 888
Energy Supply (Metabolic) Maintenance of Semipermeability of Plant Cell Membranes in the Absence of (Dr B Ginzburg), 1073
Energy Transfer with special reference to Biological Systems (Faraday Society Discussion on), 688
Engel, C E Visual Illustration of University Lectures (The Lecture Theatre of the Future), 515
Engineering Basic Geology for Science and (Prof E C Dapples), *review* by Dr J C M Taylor, 1175
  Biochemical—Unit Processes in Fermentation (edited by Dr R Steel), *review* by Dr N Blakebrough 1598
  Cryogenic (Dr Russell B Scott), *review* by Dr G G Haselden, 1174
  Low-Temperature, *review* by Dr G G Haselden, 1174
  Man the Maker—a History of Technology and (Prof R J Forbes), *review* by Dr A R Hall, 921
Engineering in the University of Birmingham, 502
Engineering at Leicester, 938
Engineering (Highway and Traffic), at Birmingham, 939
Engineering Information Services, Ltd *Digest of Soviet Technology*, No I, 320
Engineering Man-power (Scientific and), in Great Britain, 1959 (Report of the Committee on Scientific Man-power of the Advisory Council on Scientific Policy), 1982
Engineering Materials and Design Conference on New, 1362
Engineering Statics Elements of (Prof H Deresiewicz), *review* by T M Charlton, 1674
Engineering (Chemical) Scheme for a Full-time Course in (Institution of Chemical Engineers), 856
Engineering (Chemical), in Britain Progress of (Sir Hugh Beaver), 408
Engineering (Chemical), at Leeds, 1106
Engineering (Electrical) Modern Network Theory in (University of Birmingham Conference on), 1691
Engineering (Electrical), at Newcastle-upon-Tyne, 404
Engineering (Electrical), at Southampton, 590
Engineering (Electrical), in the University of Western Australia, 93
Engineering (Illuminating) Society H R H The Duke of Edinburgh to become the first Honorary Fellow, 237
Engineering Practice Chemical (edited by Herbert W Cremer and Trefor Davies), Vol 6, Fluid Systems II, *review* by Prof J M Coulson, 132
Engineers (Scientists and), in Britain, 1982
Engineers (Chemical), Institution of Presidential Address (Sir Hugh Beaver), 408
  Scheme for a Full-time Course in Chemical Engineering, 856
Engineers (Electrical), Institution of Election of Officers, B A 16
  Christmas Holiday Lecture, Colour Television (G G Gouriet), 1535
Engineers (Electrical), Institution of, and the British Nuclear Energy Conference Convention on Thermonuclear Processes, 240
Engineers (Electrical), Institution of (Electronics and Communications Section) International Convention on Transistors and Associated Semiconductor Devices, 693
  International Transistor Exhibition, 693
Engineers (Electrical), Institution of (Electronics and Communications Section), and the International Federation for Medical Electronics Third International Conference on Medical Electronics, 1535
Engineers (Environmental), Society of Formation of, 408
Engineers (Gas), Institution of, and the British Coke Research Association (Coke Oven Managers' Association, the) Joint Meeting, 1778
Engineers (Instrumentation) Differential Equations for, *review* by Prof T A A Broadbent, 6
Engineers (Mechanical), American Society of Colloquium on Mechanical Impedance Methods for Mechanical Vibrations, 1958 (edited by R Plunkett), *review* by Prof R E D Bishop, 1764
Engineers (Mechanical), Institution of Symposium on Biomechanics, 512
  Discussion on the Computer in Production, 1613
Engineers (Mining), Institution of Election of R G Baker as president for 1960-61, 1845
  Election of A Hellemans and Dr J Taylor as honorary members, 1845
  Douglas Hay Medal awarded to A E Crook, 1845
  Maskell Peace Scholarship for 1959 awarded to P Hutchinson, 1845
Engineers (Mining, Metallurgical and Petroleum), American Institute of (Metallurgical Society of the) New series of books entitled Metallurgical Society Conferences, 1362
Engineers (Radio), British Institution of Clerk Maxwell Premium awarded to C Powell and D A Hendley, 857
  Heinrich Hertz Premium awarded to K Foster, 857
  Sir Louis Sterling Premium awarded to Dr A van Weel, 857
  Sir J C Bose Premium awarded to Dr B Ramachandra Rao, Dr M Srirama Rao and C Abhirama Reddy, 857
  Brabazon Premium awarded to Prof D G Tucker, Dr V G Welsby, R Kendall and D E N Davies, 857
  Marconi Premium awarded to Dr Morton B Prince and M Wolf, 857
Engines (Marine) Exhibition of Working Models of (Liverpool Public Museums), 1534
'England Finder' (Graticules, Ltd) 34
England (Rural), Council for the Preservation of (Sheffield and Peak District Branch) Twenty-eighth Annual Report (1959), 408
England and Wales Ninety-fifth Report (1958) of the Chief Inspector on Alkali, etc , Works in, 940
  Marital Fertility in (Prof E Grebenik), 1035
  Statistical Review of, for the Year 1957, Part 2, Tables, Civil (Registrar General), 1107
English Place-Name Society Vols 27, 28 and 29, The Place-Names of Derbyshire (Kenneth Cameron), Part I, Introduction, River-Names, etc , High Peak Hundred , Part 2, Scarsdale Hundred, Wirksworth Hundred, Morleyston and Litchurch Hundred , Part 3, Appletree Hundred, Repton and Gresley Hundred, Analyses, Index, *review* by I S Maxwell, 1767
English Rural Life, Museum of Report for 1958, 505
English Wallpaintings The Conservation of—being a Report of a Committee set up by the Central Council for the Care of Churches and the Society for the Protection of Ancient Buildings, 1119
Englishman's Food The (the late Sir Jack Drummond and Anne Wilbraham), revised by Dorothy Hollingsworth, *review* by Dr Leslie J Harris, 484
Enhanced Radiation on 200 Mc /s Correlation between the Intensity of the Umbra of Sunspots and (Per Maltby), 1391
Enhanced Solar Radio Radiation Observations of the Fine Structure of, with a Narrow-Band Spectrum Analyser (Oystein Elgaroy), 887
Enhanced Synaptic Function due to Excess Use (Dr Rosamond M Eccles and Dr R A Westerman), 460
Enhancement of Pigment Production by Pseudomonas (Dr A M Paton) 1254
Ennerdale Water Relict Fauna of—a Problem of Distribution (Dr W Pennington), 1421
Enrichment (Biogeochemical), of Fission Products (Prof Pontus Ljunggren), 912
Enseignement des Sciences, Vol I, No I, 593
Enterococcal Pyelonephritis in Mice An Experimental (Dr Arvid L Erlandson, jun , Dr Leola A Gagliardi and Dr Myron W Fisher), 561
Entomology Annual Review of, Vol 4 (edited by Edward A Steinhaus and Ray F Smith), *review* by Dr P T Haskell, 489
Entwistle, Alison, and Reiners, W J Incentives in the Building Industry (National Building Studies Special Report No 28), 98
Entwistle, Dr K M Metal Fatigue, *review*, 1438
Entwistle, P F , and others New Pests of Cocoa (*Theobroma cacao* L) in Ghana following Applications of Insecticides, 2040
Environment (Australian) Strontium-90 in the, 1957-58 (Dr F J Bryant, L J Dwyer, Dr J H Martin and Prof E W Titterton), 755
Environmental Engineers, Society of Formation of, 408
Environmental Influences on Prenatal Development (edited by Beatrice Mintz), (Development Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council) *review* by Dr D R Newth, 839
Enzymatic Decarboxylation of Stipitatonic and Puberolonic Acids Tropolone Biosynthesis—the (Prof Ronald Bentley and Clara P Thiessen), 552
Enzymatic Properties of Suspensions of Parenchymatous Liver Cells Some (Dr Keith S Henley, Ole Sorensen and H Marvin Pollard), 1400
Enzyme (Yeast) Enzymic Reduction of α-Aminoadipic Acid by (S Sagisaka and Prof K Shimura), 1709
Enzyme Chemistry Outlines of (Dr J B Neilands and Dr Paul K Stumpf), second edition, *review* by Dr Edwin C Webb, 1759
  Proceedings of the International Symposium on (Tokyo and Kyoto, 1957), (Science Council of Japan, under the auspices of the International Union of Biochemistry), *review* by Dr J B Chappell, 388
Enzyme Induction X-Ray Sensitivity and Target Volume of (Dr Helmut Pauly), 1570
Enzyme Inhibition Prevention of Foetal Development by (Prof G Kahlson and Elsa Rosengren), 1238
Enzyme Kinetics Non-Inverted versus Inverted Plots in (Dr B H J Hofstee), 1296 , (Dr Malcolm Dixon and Dr Edwin C Webb), 1298
Enzyme Labelled with Radioactive Iodine Affinity of Lysozyme with Structural Elements of the Bacterial Cell as studied with (Prof C Weibull, B Zacharias and H Beckman), 1744
Enzyme-Substrate Complex Proof of the Formation of, by 'Crossing-Paper Electrophoresis' (Prof S Nakamura, K Takeo, I Sasaki and M Murata), 638

Enzyme System Specificity of the Tryptophan Peroxidase-Oxidase (Dr R H Marchant), 1711
Enzyme System (Glycolytic) Role of the, in the Germination of Spores of *Bacillus coagulans* var *thermoacidurans* (Prof Mikio Amaha and Tomoko Nakahara), 1255
Enzyme System (A New), in the Tamarind (D Mukherjee and N A Khan), 1140
Enzyme Systems Behaviour of (Dr John M Reiner), *review* by Dr J B Chappell, 388
Enzyme Systems Responsible for Steroid Metabolism in Different Tissues and Subcellular Fractions Distribution of (Virendra B Mahesh and Frank Ulrich), 1147
Enzyme Systems (Mitochondrial) Effect of some Neuromuscular Blocking Agents on (Dr J H Koch and Dr C H Gallagher), 1039
Enzymes (Indian Institute of Science Symposium on), 1367
Enzymes (University of Wageningen Conference on), 687
Enzymes, *review* by Dr Edwin C Webb, 1759
Enzymes—Kinetics and Chemistry, *review* by Dr J B Chappell, 388
Enzymes The (edited by Paul D Boyer, Henry Lardy and Karl Myrbäck), Vol 1, Kinetics, Thermodynamics, Mechanism, Basic Properties, second edition, *review* by Dr Edwin C Webb, 1759
  Purification of (Dr B K Bachhawat), 1368
Enzymes in the Food Industry (Food Group of the Society of Chemical Industry Symposium on), 1366
Enzymes (Cell-free) Combined Use of Polymyxin and Acetone to obtain (J R Villanueva), 1565
Enzymes (Drug-Metabolizing) Stimulatory Effect of Foreign Compounds on Ascorbic Acid Biosynthesis and on (Dr A H Conney and Dr J J Burns), 363
Enzymes (Respiratory) Localization and Assay of, in Single Living Cells—Absorbancy Measurements on the *Nebenkern* (Dr Robert P Perry, Dr Bo Thorell, Dr Lennart Åkerman and Prof Britton Chance), 929 , Fluorescence Measurements of Mitochondrial Pyridine Nucleotide in Aerobiosis and Anaerobiosis (Prof Britton Chance and Dr Bo Thorell), 931 , Absorbancy Measurements on Liver and Kidney Cells (Dr Bo Thorell and Prof Britton Chance), 934
Enzymes and Radioactivity in Erythrocytes of Different Ages (Dr Lester M Levy, Harry Walter and Martin D Sass), 643
Enzymic Activities of Human Skeletal Muscle Mitochondria—a Tool in Clinical Metabolic Research (Dr L Ernster, Dr D Ikkos and Dr R Luft), 1851
Enzymic Conversion of L-Rhamnulose to L-Fuculose in *Escherichia coli* (Laura Frontali and Giorgio Tecce), 1315
Enzymic Disorder Essential Pentosuria—Renal or (Dr R C Bozian and Prof Oscar Touster), 463
Enzymic Mechanisms (Two), for Hydrogen Transport by Phenolic Œstrogens (Dr H G Williams Ashman, M Cassman and Margaret Klavins), 427
Enzymic Reduction of α-Aminoadipic Acid by Yeast Enzyme (S Sagisaka and Prof K Shimura), 1709
Eosine Reductive Photo-bleaching of—Primary Processes indicated by the Flash Technique (Shunji Kato and Masao Koizumi), 1620 , Effect of Added Substances on the Rate of Reductive Photo-bleaching (Kengo Uchida, Shunji Kato and Masao Koizumi), 1620
Ephemeris (Lunar), and the Frequency of Caesium in Terms of U T + ΔT An Error in the Determination of ΔT from the (C A Murray), 441
Ephrati-Elizur, Dr Erela, and Zamenhof, Prof Stephen Incorporation of 5-Bromouracil into Transforming Principle of *Bacillus subtilis* and its Biological Effects, 472
Ephrussi, Prof B Cytoplasmic Inheritance (Respiratory Deficiency in Yeast), 1012
Epinephrine and Norepinephrine Evidence of Side-Chain Cleavage during the Reaction of, with Ethylene Diamine (Dr Louis-P Joly and Dr Guy Nadeau), 1483
Epithelia (Squamous), in the Guinea Pig Renewal Times of some (H Platt), 1654
Epithelioma (Atypical), of Rat Occurrence of Polynucleotide Phosphorylase in (Dr Kunio Yagi, Takayuki Ozawa and Hiroshi Konogi) 1939
Epithelium (Olfactory) 'On' and 'Off'-Responses of the (Dr S F Takagi and Dr T Shibuya), 60
Eppley, Dr Richard, and others Effects of Auxin and Gibberellic Acid on Growth of *Ulothrix*, 556
Epstein, Dr Eugene E Anomalous Continuum Radiation from Jupiter, 52
Epstein, Dr S S (Timmis, G M , and) New Antimetabolites from Vitamin B_{12}, 1383
Equation (A Controversial), in Population Ecology (Dr A Milne), 1582 , (W B Yapp), 1582 , (Prof G C Varley), 1583
Equation (Warburg's) Application of, to Tissue Slices (Dr I S Longmuir and Dr Ann Bourke), 634
Equations Ordinary Differential (Dr Wilfred Kaplan), *review* by Prof T A A Broadbent, 6
Equations (Differential), for Instrumentation Engineers, *review* by Prof T A A Broadvent, 6
Equations (Partial Differential) Numerical Analysis and (George E Forsythe and Paul C Rosenbloom), *review* by Prof T A A Broadbent, 576
Equator (Magnetic) Possible Asymmetry in the Daily Range of the Geomagnetic Vertical Intensity around the (Dr C A Onwumechilli), 51
Equatorial Bird, *Quelea quelea* Effect of Photoperiod on the Gonadal Cycle in an (Dr Albert Wolfson and David P Winchester), 1658
Equatorial Bird (Xerophilous), *Quelea quelea* Duration of the Regeneration Period of the Internal Reproductive Rhythm in a (H J de S Disney, B Lofts and Dr A J Marshall), 1659
Equatorial Countercurrent (South), in the Pacific Ocean Evidence of a (Joseph L Reid, jun), 209
Equatorial Meteorology Value of Contour Analysis in (D H Johnson and Dr H T Morth), 1372
Equilibrium Vapour–Liquid (Eduard Hala, Jiři Pick, Vojtech Fried and Otakat Vilim), translated by G Standart, *review* by Dr R Sargent, 837
Equilibrium (Thermal) Influence of the Thomson Effect on the θ-φ Relationship for a Constrictive Resistance in (Dr W Davies), 975
Equilibrium Constant of the Galactokinase Reaction and Free Energy of Hydrolysis of Adenosine Triphosphate (Dr M R Atkinson, Eleanor Johnson and Prof R K Morton), 1925
Equilibrium Diagram for the System Al_2O_3-SiO_2 Revised (Shiger Aramaki and Prof Rustum Roy), 631
Equilibrium Treatise Vapour–Liquid, *review* by Dr R Sargent, 837
Equipment Hot Laboratory (United States Atomic Energy Commission), new edition, 155
Equus przewalskii The Mongolian Wild Horse (A G Bannikov), 1024 , (E Dagva), 1024 , (D Tzevegmid), 1024 , (I S Sles), 1024
Erdos, Prof E G , and others Activation and Inhibition of the Arylesterase of Human Serum, 430
Ergonomics, 421
Ergonomics Ten Years of (Alec Rodger), B A 20
Ergonomics Research Society Symposium on Ergonomics, its Place in Industry (Past Progress and Future Trends), B A 20
Ergun, S , and MacCartney, J T Coal Science (Spectroscopy of Coals—Light Spectroscopy), 413
Ergun, S , and Wender, I Coal Science (X-ray Scattering of Vitrinites reduced with Lithium in Ethylene Diamine), 412
Ergun, S , and others Coal Science (Ultra-fine Structure of Coals and Chars), 413
Eriophorum vaginatum L Mineral Uptake and Retention in Cotton-Grass (Gordon T Goodman and Donald F Perkins), 467, *erratum*, 1845
Eriophyses Floral Malformation in *Panicum antidotale* caused by a Species of (Dr V M Desai and Dr M J Thirumalachar), 1586
Erkrankten Zahngewebe des Menschen und der Wirbeltiere im Polarisationsmikroscop Die gesunden und die (Prof W J Schmidt und Dr A Keil), *review* by Prof A I Darling, 218
Erlandson, jun , Dr Arvid L , and others An Experimental Enterococcal Pyelonephritis in Mice, 561
Erley, D S , and others Post-Exposure Analysis of Organic Compounds in the Blood by a Rapid Infra-red Technique, 192
Ernster, Dr L , and others Enzymic Activities of Human Skeletal Muscle Mitochondria—a Tool in Clinical Metabolic Research, 1851
Erosion (Coast), and Accretion (British Association for the Advancement of Science, Sections E (Geography) and K (Botany), Discussion on), 499
Error in the Determination of ΔT from the Lunar Ephemeris and the Frequency of Caesium in Terms of U T + ΔT (C A Murray), 441
Erythrocyte of the Lizard *Trachysaurus rugosus* (Gray) Effects of Elevated Plasma Sodium Concentration on Sodium and Potassium in the (P J Bentley), 1403
Erythrocyte Membrane (Human) Active Transport of Uric Acid through the (Dr Kay Overgaard-Hansen and Dr Ulrik V Lassen), 553
Erythrocytes Influence of X-Rays on the Activity of Carbonic Anhydrase in, and on their Haemolytic Resistance (A Lauwers, J Van Bavinchove and W Dierick), 111
  Nonhaem Iron in, as a Precursor for Haemoglobin (Dr M Faber and Dr I Falbe-Hansen), 1043
Erythrocytes of Different Ages Enzymes and Radioactivity in (Dr Lester M Levy, Harry Walter and Martin D Sass), 643
Erythrocytes coated with Incomplete Antibodies Loss of Plasticity of (Prof C T Nicolau, P Teitel and M Fotino), 1808
Erythrocytes in Iranians Glutathione Stability of the (Dr D G Walker and Dr J E Bowman), 1325
Erythrocytes (Human) Glucose-6-phosphate Dehydrogenase and—Characteristics of Glucose-6-phosphate Dehydrogenase from Normal and Primaquine-sensitive Erythrocytes (Dr Henry N Kirkman), 1291 , Mechanism of Inactivation of Glucose-6-phosphate Dehydrogenase in Human Erythrocytes (Dr Paul E Carson, Stanley L Schrier and Robert W Kellermeyer), 1292
  Mechanism of Inactivation of Glucose-6-phosphate Dehydrogenase in (Glucose-6-phosphate Dehydrogenase and Human Erythrocytes), (Dr Paul E Carson, Stanley L Schrier and Robert W Kellermeyer), 1292
Erythrocytes (Mammalian) Metabolic Changes induced in, by Whole-Body X-Irradiation (Prof D A Rappoport and B W Sewell), 846
Erythrocytes (Normal and Primaquine-sensitive) Characteristics of Glucose-6-phosphate Dehydrogenase from (Glucose-6-phosphate Dehydrogenase and Human Erythrocytes), (Dr Henry N Kirkman), 1291
Erythrocytes (Tanned), in the Rabbit Production of an Agglutinating Auto-Antibody (Panagglutinin) Active upon (P O Hubinont, P Ghysdael and O Thys), 1250
Erythrocytes and Endotoxins Interaction of (V Bokkenheuser and H J Koornhof), 109
Erythroid Cells (Human), *in vitro* Lack of Direct Effect of Erythropoietin on (Edward L Alpen, L G Lajtha and Donald C Van Dyke), 1228
Erythropoietic Factor Disappearance of the, from Plasma of Anaemic Dogs after Nephrectomy (Dr Jean-Pierre Naets), 371
Erythropoietin Lack of Direct Effect of, on Human Erythroid Cells *in vitro* (Edward L Alpen, L G Lajtha and Donald C Van Dyke), 1228
Escherichia coli Enzymic Conversion of L-Rhamnulose to L-Fuculose in (Laura Frontali and Giorgio Tecce), 1315
  N,O-Diacetylneuraminic Acid and *N*-Acetylneuraminic Acid in (Dr C W De Witt and J A Rowe), 381
  Effect of Purine and Pyrimidine Analogues on Reversion of a Tryptophan-requiring Strain of (C O Doudney and F L Haas), 114
  Influence of DL-beta-Phenylserine on the Synthesis of Proteins in (J Janeček, J Chaloupka, K Vereš and M Havranek), 1895
Escherichia coli K-12 (Lysogenic) Induction of Phage Formation in the, by Mitomycin C (Dr Nozomu Otsuji, Dr Mutsuo Sekiguchi, Dr Teiji Iijima and Dr Yasuyuki Takagi), 1079
Escherichia coli 15*T* Influence of Unbalanced Growth on Subsequent X-Ray Induced Inhibition of Deoxyribonucleic Acid Synthesis in (Daniel Billen), 174
E coli adsorbed on a Resin, 'Dowex-I' Chemical Activities of (Tsutomu Hattori and Choseki Furusaka), 1566
Eserine Effect of Acetylcholine and, on the Spawning of *Hydractinia echinata* (M Yoshida), 1151
ESP Experimental Evidence for (C M Hansel), 1515
Espinosa, Dr E Production of γ- and α-Globulins by the Isolated and Perfused Rat Spleen, 1801
Essen, Dr L , and Parry, J V L An Improved Caesium Frequency and Time Standard, 1791
Essential Hypertension Haemodynamics in (Dr J Brod, V Fencl, Z Hej and J Jirka), 1643

Essential Pentosuria—Renal or Enzymic Disorder (Dr R C Bozian and Prof Oscar Touster), 463
Essentials of Human Reproduction (edited by Prof Joseph Thomas Velardo), *review* by Dr T Mann, 1434
Establishment of Parenchymatous Spleno-Pulmonary Venous Anastomosis (Dr George R Walker, Dr Paul Field and Dr Patrick E Conen), 703
Estborn, Dr Bengt Visualization of Acid and Alkaline Phosphatase after Starch-Gel Electrophoresis of Seminal Plasma, Serum and Bile, 1636
Esterase Inhibition and Organophosphorus Poisoning in the House-Fly (Dr D Stegwee), 1253
Esters (Carbohydrate Sulphate) Infra-Red Spectra of (Dr A G Lloyd and K S Dodgson), 548
Esters (Long-Chain Fatty Acid Methyl) Gas Chromatographic Separation of, on Polyvinyl Acetate (Irwin Hornstein, L E Elliott and P F Crowe), 1710
Esters (Phospholipid Phosphoric), in the Human Placenta (G Porcellati, B Curti and S Luciani), 1870
Esteve, J Martin, and others Radiomimetic Action of Lipoxidase, 1506
Estimates, Select Committee on, Session 1958-59 Seventh Special Report, Treasury Control of Expenditure (Observations of the Treasury), 696
Estimating Earthworm Populations by using Formalin (Dr F Raw), 1661
Estimation of Chain Fracture and Cross-Linking of Rubber by High-Energy Radiation (P Hayden), 1865
Estimation of the Interchange Energy for Binary Systems from Mutual Solubility Data (Kiyoharu Ishida), 814
Estimation of Linear and Non-Linear Structural Relations (D E Barton and C L Mallows), 1086
Estimation of μgm Quantities of Iron in Culture Medium using Bathophenanthroline (P A Seamer), 636
Estimation of Small Percentages of Foetal Haemoglobin (Prof K Betke, H R Marti and I Schlicht), 1877
Estimation of Vitamin C by Agar Diffusion (Alan H Chaiet and Louis Chaiet), 1487
Estimation (Colorimetric), of Citric Acid (Prof R E Macdonald and W E Waterbury), 988
Estimation (Nitrite), by Diazotization Measurement of Inhibition by Azide in Biochemical Assay Systems involving (Dr E J Hewitt and D G Hallas), 1485
Estimation (Quantitative), of the Fatty Acids of Olive Oil (J Gracian, E Vioque and Mª Pilar de la Maza), 1941
Estimation (Rapid), of the Specific Surface of a Powder (Dr H E Rose and R M E Sullivan), 46
Etching of Calcite (Dr N S Pandya and J R Pandya), 894
Ethanol Increase in the γ-Aminobutyric Acid Content of Rat Brain after Ingestion of (Dr H -M Hakkinen and E Kulonen) 726
Ethanol Tolerance of Rats Sex Difference in (Henrik Wallgren), 726
Ethanol in Chloroform A Concave Concentration Gradient of, employed in Elution of Lipids from Silicic Acid (J J Wren) 816
Ethanol in Man Extrahepatic Metabolism of (Dr J A Larsen), 1236
Ethanol Metabolism Relation of, to Several Factors in the Rat (Dr F W Kinard, J C Aull, jun , and R E Ulmer), 1721
Elher (3,4,ω-Trihydroxyacetophenone 3-methyl), in Adrenal Extracts (J von Euw, Prof T Reichstein, R Neher, Dr A Wettstein, Dr J F Tait and Dr S A S Tait) 268
Ethers (Isomeric O-Methyl), of Ethyl di-(4-hydroxycoumarinyl-3)-Acetate (the Anti-coagulant Drug Pelentane or Thromexane), (Dr Eduard Knobloch), 1568
Ethyl Alcohol Oxidation of, by a Mixture of Hydrogen Peroxide and Ferric Salts (Dr Mordechai L Kremer), 720
Ethyl di-(4-hydroxycoumarinyl-3)-Acetate (the Anti-coagulant Drug Pelentane or Thromexane) Isomeric O-Methyl Ethers of (Dr Eduard Knobloch), 1568
Ethyl Methane Sulphonate Mutation of Bacteria at High Levels of Survival by (Anthony Loveless and Sheila Howarth), 1780
17α-Ethyl-19-Nortestosterone Prolonged Survival of Dystrophic Mice treated with (Dr Robert M Dowben), 1966
Ethylene A Chemical Effect of, during the Storage of Peas (Prof Frank A Lee), 462
  Production of, by Mitochondria from Tomatoes (Prof Mary S Spencer), 1231
Ethylene *Bis*dithiocarbamates Insecticidal Action of (R D McMullen), 1338
Ethylene Diamine Evidence of Side-Chain Cleavage during the Reaction of Epinephrine and Norepinephrine with (Dr Louis-P Joly and Dr Guy Nadeau), 1483
Ethylenediamine Tetra-acetate Effect of, on Vitamin B_{12} Absorption in the Rat (Edward G Rice, Dr Samuel M Greenberg, John F Herndon and E J Van Loon), 1948
Etres Vivants Causes de la Répartition des (Raymond Furon), *review* by Prof Ronald Good, 390
Etruscan Origins Ciba Foundation Symposium on Medical Biology and (edited by G E W Wolstenholme and Cecilia M O'Connor), *review* by Madeleine Smith, 1348
Etruscans The Future of the, *review* by Madeleine Smith, 1348
Ettinger, R (Patterson, A , and) Fast Chemical Reactions in Solution (Carbon Dioxide–Water Equilibrium, using Nuclear Magnetic Resonance Methods), 1453
Ettori, Prof J and Scoggan, Sybil M Ionized Calcium in Biological Media, 1315
l'Etude Agronomique du Congo Belge Institut National pour Carte des Sols et de la Vegetation du Congo Belge et du Ruanda-Urundi, 6, Yangambi, Planchette 3, Lilanda, A, Sols , B Vegetation (Notice explicative par P Gilson, P Jongen, A Van Wambeke et L Liben), 27
  Publications, *Série* Scientique No 75, Moisissures du Sol et des Litières de la Région de Yangambi (J Meyer), 236
  Publications, Série Scientifique No 77, Recherches sur les Affinités Chromosomiques dans le Genre *Coffea* (J Bouharmont) 518
  Publications, Série Scientifique No 78, Recherches sur l'Autostérilité du Caféier robusta (*Coffea canephora* Pierre), (M Devreuk, G Vallaeys, P Rochet et G Filles), 518
l Etude Taxonomique de la Flore d'Afrique Tropicale, Association pour Vegetation Map of Africa (Explanatory notes by R W J Keay, with a French translation by A Aubreville), 594
Eucalyptus Floral Morphology and the Taxonomy of (Dr D J Carr and S G M Carr), 1549
Euglena gracilis A Biological Action of Deoxyribonuclease I on the Growth of (Dr Rudolf K Zahn), 1324
Eupagurus bernhardus (The Hermit Crab) The Sea Anemone (*Calliactis parasitica*) and (Dr D M Ross), 1161
Euphausiid *Thysanoessa raschii* Spectral Composition of the Luminescence of the (Dr Brian P Boden and Dr Elizabeth M Kampa), 1321
Europe The Profession of Government—the Public Service in (Dr Brian Chapman), 127
European Comparisons The Spirit of British Administration and some (C H Sisson) 128
European Corn Borer, *Ostrinia rubilalis* (Hbn) (Lepidoptera Pyralidae) Chemical Changes associated with Diapause in the (J A Mutchmor and J H Maruzek), 1077
European Economic Co-operation, Organization for First Meeting of the International Board of Management of the *Dragon* Project, 24
  Dragon Project of the, 24, 942
European Economic Co-operation, Organization for (European Nuclear Energy Agency) Formation of a Committee for European-American Nuclear Data, 1271
  Second Fuel Charge for the Boiling Heavy Water Reactor Project at Halden, Norway, 1844
European Economic Co-operation, Organization for (European Productivity Agency) Project 335, Fitting the Job to the Worker, a Survey of American and European Working Conditions in Industry, 422
European Nuclear Energy Agency of the Organization for European Economic Co-operation Foundation of a Committee for European—American Nuclear Data, 1271
  Second Fuel Charge for the Boiling Heavy Water Reactor Project at Halden, Norway, 1844
European Nuclear Energy Project, *Dragon*, 24, 942
European Nuclear Energy Research, 1278
European Organization for Nuclear Research (CERN) Present Status, 944
  International Co-operation in the field of High-Energy Accelerators, 1844
  Election of Officers, 1844
European Productivity Agency of the Organization for European Economic Co-operation Project 335, Fitting the Job to the Worker, a Survey of American and European Working Conditions in Industry, 422
European Research Associates, Brussels Grant of £1,200 to the University of Oxford, for research on acetylene chemistry, 1362
European Working Conditions (American and), in Industry Fitting the Job to the Worker—a Survey of (European Productivity Agency of the Organization for European Economic Co-operation, Project 335), 422
European–American Nuclear Data Committee for (European Nuclear Energy Agency of the Organization for European Economic Co-operation), 1271
Eutherian Mammals Chromosomal Evolution in (Prof Robert Matthey), 1329
Evans, E Ll (Kubaschewski, Dr O , and) Metallurgical Thermochemistry, *review* by Dr F C Thompson, 1765
Evans, G O Mites, or the Acari, *review*, 1677
Evans, Dr H E Appointed lecturer in engineering at the University College of Swansea, 156
Evans, J C , and others Sodium Regulation in the Blood of Parr and Smolt Stages of the Atlantic Salmon, 283
Evans, Dr J H Value of a Simple Observational Technique for Determining the Fat Content of Algal Cells, 1737
Evans, J V , and others Ultra-structure of the Myoneural Junction in Myasthenia Gravis, 1500
Evans, J V and Taylor, G N Radio Echo Observations of Venus, 1358
Evans-Pritchard, Prof E E An Anthropologist at Work *review*, 301
Even-Aged Plantations Pathogenic Factors in the Rooting Space and the Development of (W R Day), B A 46
Everard, C O R , and Feder, William A Effective Increase in Nematode Populations by the Addition of Aureomycin, 1887
Everett, D H , and Stone, F S (edited by) The Structure and Properties of Porous Materials—Proceedings of the Tenth Symposium of the Colston Research Society held in the University of Bristol, 1958, *review*, 1525
Evidence for Cosmic Ray Energy Spectrum Changes during a Forbush Decrease (K W Ogilvie and M M Winn), 888
Evidence for Distinct Sectors in Polymer Single Crystals (D C Bassett, Prof F C Frank and Dr A Keller), 810
Evidence from Distribution of Hydrogen Structure of Bituminous Coals—(Dr P H Given), 980
Evidence for a Hydrate of Cellulose from Studies of its Surface Properties (Dr J M Joubert, Dr G J R Krige and Dr K Borgin), 1561
Evidence for Phosphatidic Acid as the Sodium Carrier (Dr Lowell E Hokin and Mabel R Hokin), 1068
Evidence of Side-Chain Cleavage during the Reaction of Epinephrine and Norepinephrine with Ethylene Diamine (Dr Louis-P Joly and Dr Guy Nadeau), 1483
Evidence for a Sliding Filament Contractile Mechanism in Tonic Smooth Muscles of Lamellibranch Molluscs (Dr Jean Hanson and Dr J Lowy), 286
Evidence of a South Equatorial Counter-current in the Pacific Ocean (Joseph L Reid, jun), 209
Evidence (Experimental), for Extra-Sensory-Perception (C M Hansel), 1515
Evidence (Experimental) for Weeping Lubrication in Mammalian Joints (Mechanism of Animal Joints), (P R Lewis and Dr C W McCutchen), 1285
Evidence (Pharmacological), for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysical Extracts from Cold-blooded Vertebrates (Active Principles of the Neurohypophysis of Cold-blooded Vertebrates), (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464
Evitt, W R Origin and Dispersal of Flowering Plants (Palaeozoic Marine Sequences from New York and Australia), 1200
Evoked Potentials in Visual Cortex of the Unanaesthetized Cat (Gabriel Horn and John Blundell), 173
Evolution Behavior and (edited by Anne Roe and George Gaylord Simpson), *review* by Dr W H Thorpe, 1762
  Conception of—Meeting in Paris (Dr J Ramsbottom), 859
  Intraspecific Polyploidy and, of Diverse Morphological Forms of *Convolvulus pluricaulis* Chois (Dr S L Tandon and C P Mzalik), 481

Evolution of Behaviour, *review* by Dr W H Thorpe, 1762
Evolution of Host–Parasite Relationships (British Association for the Advancement of Science, Section D (Zoology), Symposium on), 760
Evolution of the Human Brain James Arthur Lecture on the—The Discrete and the Diffuse in Nervous Action (Prof P D C Lloyd), 1777
Evolution of Living Species (Royal Society of Victoria Symposium on), 156
Evolution of North America (Dr Philip B King), *review* by Dr J W Cowie, 1600
Evolution der Tiere Die Banderschnecken, eine Studie zur (Prof Dr F A Schilder und Dr Maria Schilder), *review* by Dr A J Cain, 390
Evolution (Chromosomal), in Eutherian Mammals (Prof Robert Matthey), 1329
Evolution (Social), in Man Main Stages of (Dr Max Pettersson), 481
Ewan, J Origin and Dispersal of Flowering Plants (Zoogeographical Data in the Interpretation of Existing Floristic Patterns), 1201
Ewe (Ovariectomized) Seasonal Changes in the Œstrous Response by the, to Progesterone and Œstrogen (Prof J I Raeside and M F McDonald), 458
Ewes (Ovariectomized) Maintenance of Pregnancy in, by means of Progesterone (N W Moore and L E A Rowson), 1410
Ewes' Milk Effect of Cobaltic Oxide Pellets on the Vitamin B$_{12}$ Content of (L I Hart and E D Andrews), 1242
Examination (Direct Spectroscopic), of Electrophoretic Zones in Agar Gel (Dr G H Beaven and W B Gratzer), 359
Excerpta Medica Foundation Cancer Current Literature Index, 941
Excess Hydrocortisone Mechanism of the Atherogenic Action of (Dr Henry Grossfeld), 38
Excess of Iron in the Forage A Lesion of the Follicle and of the Fibre of Wool and its Possible Relation with an (Prof G Gonzelez, J Garcia and E Fernandez), 559
Excess Use Enhanced Synaptic Function due to (Dr Rosamond M Eccles and Dr R A Westerman), 460
Exchange of Potassium-42 by the Foetal Metanephros and Foetal Liver Relative Rates of (Dr J G Bearn and Dr F T C Harris), 1959
Exchange (Radioactive) Labelling of Rose Bengal with Iodine-131 by (J Leibster and O Andrysek), 913
Exchange (Tritium) *In vitro* Labelling of Antibody Globulin by (Dr P C Rajam and Anne-Louise Jackson), 375
Exchange Interaction as a Cause of Reverse Thermo-Remanent Magnetism (T Nagata and S Uyeda), 890
Exchangeable Cations in Vermiculite Diffusion of (G F Walker), 1392
Exchangeable Phosphate (Isotopically), in Soil Effect of the Level of Microbial Population on (Dr P Newbould and Dr R L Lucas), 1155
Exchangers (Anion), based on Cellulose (Dr A O Jakubovic), 1065
Exchanges between Soviet and United States Scientists, 680
Excised Tomato Roots Nitrate Reduction by Aqueous Extracts of (C S Vaidyanathan and Prof H E Street), 531
  A Non-Dialysable Inhibitor of Glutamo-Transfarase present in (C S Vaidyanathan and Prof H E Street), 347
Excitability and Phosphorylation of Muscle and Nerve in Sodium-free Hydrazinium Solution (L G Abood and K Koketsu), 725
Excitation (Electronic) Transfer Mechanisms of (Prof Th Forster), 688
Excretion of Labelled Magnesium by the Sheep (D C Macdonald, A D Care and B Nolan), 736
Excretion (Urinary), of β-Amino-*iso*butyric Acid in Mongolism (Dr Thomas L Perry, Dr Kenneth N F Shaw and Dr Dorothy Walker), 1970
Excretion (Urinary), of some B Vitamins in Man Effect of Sorbitol on the (J D Watson and Prof John Yudkin), 911, *errata* 1362
Excretors (β-Amino-*iso*butyric Acid) High Prevalence of High-Level, in Micronesians (Dr B S Blumberg and Dr S M Gartler), 1990
Excursion Flora of the British Isles (Prof A R Clapham, Prof T G Tutin and Dr E F Warburg), *review* by P Falk, 1093
Executive Development Sandwich Course in (Sheffield College of Technology), 235
Exercise (Flight) Release by, of a Chemotropic Response from Photopositive Domination in a Scolytid Beetle (Prof Kenneth Graham), 283
Exhibition (Physical Society), 1688
Exhibition International Transistor (Electronics and Communications Section of the Institution of Electrical Engineers), 693
Exhibition of 1851, Royal Commission for the Awards of Studentships and Scholarships, 409
Exhibition of Aerial Photographs of Quarries and Mines (Geological Museum), 855
Exhibition of Electronic Devices Fourteenth (Northern Division of the Institution of Electronics), 1277
Exhibition of Engineering Materials and Design First 1362
Exhibition in Moscow of British Books and Periodicals (British Council and the Soviet Ministry of Culture), 1361
Exhibition of Working Models of Marine Engines (Liverpool Public Museums), 1534
Exhibition (Science) The Cape Town, 1959 (Dr Ronald Singer), 952
Existence of an Inner Auroral Zone (Dr Knud Lassen), 1375
Expanding Universities Administrative Problems in (Home Universities Conference 1959), 1613
Expansion of Educational and Training Facilities in Britain, 569
Expansion of University Education in Britain, 1431
Expansion (Permanent Moisture), of Clay Products on Natural Exposure (J S Hosking and H V Hueber), 1373
Expansion (Urban) Trends in (Prof K C Edwards), B A 43
Expenditure Treasury Control of (Observations of the Treasury), (Seventh Special Report from the Select Committee on Estimates, Session 1958-59), 696
Expenditure (Government Research and Development), in Britain Control of, 696
Expenditure (Public) Control of, 857
Expenditure (United States), on Research and Development in 1957, 1022
Experience The Nature of (Sir Russell Brain), *review* by F I G Rawlins, 218
Experimental 'Allergic' Encephalomyelitis Various Types of Acquired Resistance to (G J Svet-Moldavsky, I A Svet-Moldavskaya and L I Raffkina), 1552
Experimental Animals Differential Analysis of the Effects of Phenothiazine-Tranquillizers on Emotional and Motor Behaviour in (Dr M Taeschler and Dr A Cerletti), 823
Experimental Conditions Force-Feeding Fish under (Dr J M Dodd, Dr M H I Dodd and Dr C K Goddard), 1650
Experimental Demonstration of an Internal Rhythm of Reproduction in a Trans-Equatorial Migrant (the Short-tailed Shearwater *Puffinus tenuirostris*), (Dr A J Marshall and Dr D L Serventy), 1704
Experimental Diphtheric Intoxication Effect of Tranquillizing Drugs on Survival from (Prof Leo Greenberg and Dr James W Ingalls), 1721
Experimental Enterococcal Pyelonephritis in Mice (Dr Arvid L Erlandson, jun, Dr Leola A Gagliardi and Dr Myron W Fisher), 561
Experimental Evidence for Extra-Sensory-Perception (C M Hansel), 1515
Experimental Evidence for Weeping Lubrication in Mammalian Joints (Mechanism of Animal Joints), (P R Lewis and Dr C W McCutchen), 1285
Experimental Galactose Cataract Carbohydrate Metabolism in the (Dr Sidney Lerman), 1406
Experimental Music—Composition with an Electronic Computer (Prof L A Hiller, Jr, and Leonard M Isaacson), *review* by Prof E G Richardson, 1754
Experimental Production of Magnesium Deficiency in Lambs on a Diet containing Roughage (Dr D M McAleese and Dr R M Forbes), 2025
Experimental Science A History of Magic and (Prof Lynn Thorndike), Vols 7 and 8, The Seventeenth Century, *review* by Dr V A Eyles, 1899
Experimental Technique (Humane) The Principles of (Dr W M S Russell and R L Burch), *review* by Prof M Weatherall, 1675
Experimental Techniques Structure Analysis and (Institute of Physics Conference on), 857
Experimental Techniques in Low-Temperature Physics (Guy Kendall White), *review* by Prof J F Allen, 1260
Experimental Test (A New), of Special Relativity (J P Cedarholm and Prof C H Townes), 1350
Experimental Tests of Quantum Electro-dynamics (Prof W E Lamb), 954
Experiments Humane, *review* by Prof M Weatherall, 1675
  Planning of (Dr D R Cox), 156
Experiments on the Acousto-Electric Effect (Piroska Smith (*nee* Vermes) and D O Sproule) 264
Experiments on Automobile Collisions (Prof J H Mathewson), 237
Experiments on the Development of Isolated Blastomeres of Mouse Eggs (Dr Andrzej K Tarkowski), 1286
Experiments on Duck Red Cells *in vitro* Role of Stroma in Haemoglobin Synthesis—(A Breccia, A L Fantola, E Lazzarini and A Giustina), 1878
Experiments on Rice's Blue Material Some (J W Clarke and G McTurk), 2014
Experiments on Wool from Copper-deficient Sheep (R W Burley and F W A Horden), 1725
Experiments (Carbon-14 Dioxide), with Hydrocortisone Liver Glucosyl Oligosaccharides and Glycogen—(Dr Hsien-Gieh Sie, Prof James Ashmore, Dr Robert Mahler and Prof William H Fishman), 1380
Experiments (Sterol-Balance), in Humans (Dr Harald Schon), 1872
Explanation (A Possible), of the Formation of Long Platelets from Pulmonary Megakaryocytes (Dr J George Sharnoff), B A 75
Explanation (A Possible), for Part of the Difference in Heat Tolerance Exhibited by *Bos taurus* and *Bos indicus* Beef Cattle (H P Ledger), 1405
Exploitation of Natural Animal Populations (British Ecological Society Symposium on), 1451
Exploration du Parc National de la Garamba Mission H de Saeger, Fasc 9, Écologie et Biologie des Grands Mammifères (Primates, Carnivores, Ongulés), (Jacques Verschuren), 155
Exploration of the Sea International Council for the Special International Geophysical Year Meeting (A J Lee and Dr D H Cushing), 1180
Explosion (Nuclear) (Johnston Island) Disturbance in the Ionospheric *F*-Region following the (C H Cummack and G A M King), B A
Explosion (Primer), Triggers Reaction (G Larikov), 447
Explosions in Solids, *review* by Dr Peter Gray, 664
Explosions (Nuclear) Geomagnetic and Ionospheric Phenomena associated with (Dr S Matsushita), B A 33
  Geophysical Effects of High-Altitude (W A Feibelman), 442
  Magnetic Effects resulting from Two High-Altitude (J A Lawrie, V B Gerard and P J Gill), B A 34
  Some Geomagnetic Phenomena associated with (Dr R G Mason and Dr M J Vitousek), B A 52
Explosions (Underground Test), in Britain, 1532
Exposure (Natural) Permanent Moisture Expansion of Clay Products on (J S Hosking and H V Hueber), 1373
Exposure (Occupational) Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for (United States National Bureau of Standards, Handbook 69), 939
Extended Dormancy of Deciduous Woody Plants treated in Autumn with Gibberellic Acid (Dr P W Brian, J H P Petty and P T Richmond), 69
Extent of Blood Sampling Effect of Dietary Fat and, on the Level of Plasma Cholesterol in the Rat (I Coleman and J M R Beveridge), 1039
External Worlds The Internal and the (Sir Cyril Hinshelwood), 1834
Exteroceptive Block to Pregnancy in the Mouse (Hilda M Bruce), 105
Extra-Sensory-Perception Experimental Evidence for (C M Hansel), 1515
Extra-Terrestrial Flight Behaviour in Conventional and (Air Commodore W K Stewart), 578
Extracellular Polysaccharide of *Azotobacter vinelandii* A Function for the (Dr Michael H Proctor), 1934
Extracorporeal Circuits Release of Adenosine Triphosphate and Serotonin from Injured Cellular Blood Elements in (Dr H S S Sarajas, Dr R Kristoffersson and Dr M H Frick), 1127
Extract (Whole Hypothalamic) Effects of Methylthiouracil or Thyroidectomy on Activation of Pituitary Acid Phosphatases *in vitro* by (Dr V Schreiber and Dr V Kmentova), 728
Extracting Plant Embryos from certain Types of Seeds A Quick Method for (M D Gwynne), 1588
Extraction of an Actomyosin-like Protein from Human Thrombocytes (M Bettex-Galland and Dr E F Luscher), 276
Extraction of Radioactivity from Air Condensation Processes for the (Rama), 1789

Extraction of the Total Protein from Wheaten Flour in the Form of Soluble Derivatives (E E McDermott and Dr J Pace), 546
Extraction and Purification of 'Queen Substance' from Queen Bees (Dr C G Butler, Dr R K Callow and Norah C Johnston), 1871
Extracts of *Albizia* Species Physiological Activity in (A Lipton), 822
Extracts (Adrenal) 3,4,ω-Trihydroxyacetophenone 3-Methyl Ether in (J von Euw, Prof T Reichstein, R Neher, Dr A Wettstein, Dr J F Tait and Dr S A S Tait), 268
Extracts (Animal Tissue) Occurrence and Quantitative Determination of 2-Dimethylaminoethanol in (Dr Conrad G Honegger and Ruth Honegger), 550, *erratum*, 1986
Extracts (Aqueous), of Excised Tomato Roots Nitrate Reduction by (C S Vaidyanathan and Prof H E Street), 531
Extracts (Carrot) Biosynthesis of Carotenes in (Dr V V Modi and D K Patwa), 983
Extracts (Cell-Free) Effect of, from *Mycobacterium tuberculosis* H_{37} *Rv* on Lung Succinooxidase (Dr A Bekierkunst and M Artman), 458
Extracts (Coal) Biological Properties of Coal and (Dr A A Mills), 1885
Extracts (Fish and Frog Hypophysial) Chromatographic and Biological Characteristics of (Active Principles of the Neurohypophysis of Cold-blooded Vertebrates), (B T Pickering and Prof H Heller), 1463
Extracts (Forest-Tree Litter) Factors in, affecting the Growth of Soil Micro-Organisms (Dr Roger Knowles and Edward Laishley), 1169
Extracts (Juvenile Hormone), of Insects Prothoracic Gland Stimulation by (Dr Lawrence I Gilbert and Dr Howard A Schneiderman) 171
Extracts (Neurohypophysial), from Cold-blooded Vertebrates Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in (Active Principles for the Neurohypophysis of Cold-blooded Vertebrates), (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464
Extracts (Plant) Tumour Production in Plants by (Dr Archana Sharma), 1083
Extracts (Soya) A Lipoperoxidase Factor in (Dr John A Blain and Edward C C Styles), 1141
Extracts (Tomato Crown-Gall Tissue) Occurrence of 3-Indolylacetic and 3-Indolecarboxylic Acids in (G Clarke, M H Dye and Prof R L Wain), 825
Extracts (Trypanosomal) Paper Electrophoresis of (Dr Robert S Desowitz), 986
Extrahepatic Metabolism of Ethanol in Man (Dr J A Larsen), 1236
Extreme Sensitivity of Germination and Photoperiodic Reaction in the Genus *Chenopodium* (Tourn) L (Dr Bruce G Cumming), 1044
Extremely High Temperatures (Electronics Research Directorate of the United States Air Force Cambridge Research Center Conference on, Boston, 1958), (edited by Dr Heinz Fischer and Lawrence C Mansur), *review* by Dr T E Allibone, 83
Extremely Low Temperature Prefreezing as a Method enabling Animals to survive Freezing at an (Eizo Asahina), 1003
Extremes Statistics of (Prof E J Gumbel), *review* by R N Curnow, 754
Eye Association between Colour of the Iris of the, and Reaction to Dental Pain (Dr Philip R N Sutton), 122
Eye Movement Recording (G H Byford), 1493
Eye Tissues Distribution of Radioactive Barium in (R J Garner), 733
Eyles, Dr V A A History of Magic and Experimental Science, *review*, 1899
Eyring, H Fast Chemical Reactions in Solution (Solution Structure and Fast Reactions), 1454

F-REGION (Ionospheric) Disturbance in the, following the Johnston Island Nuclear Explosion (C H Cummack and G A M King), B A 32
F_2 Ionospheric Layer Tides in the (Dr P Herrinck), 1055
*F*2 Layer of the Ionosphere Two Anomalies in the Behaviour of the (Sheila Croom, Audrey Robbins and J O Thomas), 2003
Faber, Dr M , and Falbe-Hansen, Dr I . Nonhaem Iron in Erythrocytes as a Precusor for Haemoglobin, 1043
Fabian Society Research Series No 209, The Universities—a Royal Commission (G C Moodie) 1432
Facial Eczema of Sheep in the Field *Sporidesmium bakeri* and (R H Thornton and D P Sinclair), 1327
Facilities (Educational and Training) in Britain Expansion of, 569
Factor (Antilipaemic X), of the Unsaponifiable Fraction of Crude Vegetable Oils Chromatographic Identification of the (Prof M C Nath, A Saikia and B I Uppin), 1635
Factor (Fertility), in *Salmonella typhimurium* (T Miyake), 657
Factor (Growth-Promoting) and a Tumour-Susceptibility Factor in Eggs Differentiation between a (Charles H Hill and Henry W Garren), 824
Factor (Histamine Sensitizing) Formation of the Toxoid of, in *Bordetella pertussis* (Prof Toshitaka Matsui and Yoshio Kuwajima), 199
Factor (A Lipoperoxidase), in Soya Extracts (Dr John A Blain and Edward C C Styles), 1141
Factor (Quadrupole Anti-Shielding), in Copper (E A Faulkner), 442
Factor (Serum) Transformation Reaction of Pneumococci in the Absence of (Prof Takeshi Odaka and Tadashi Watanabe), 471
Factor (Tumour-Susceptibility), in Eggs Differentiation between a Growth-Promoting Factor and a (Charles H Hill and Henry W Garren), 824
Factories, Chief Inspector of Annual Report on Industrial Health for 1958 (Ministry of Labour and National Service), 1023
  Annual Report for 1958 (Ministry of Labour and National Service), 1456
Factors Unidentified Chick Growth (J A Wakelam and W P Jafie), 272
  Unidentified Growth (K A Allen, J Stephens, W P Jaffe and J A Wakelam), 271
Factors in Forest-Tree Litter Extracts affecting the Growth of Soil Micro-Organisms (Dr Roger Knowles and Edward Laishley), 1169
Factors in the Rat Relation of Ethanol Metabolism to several (Dr F W Kinard, J C Aull, jun , and R E Ulmer), 1721
Factors (Dietary), in the Homograft Reaction (Dr A S Parkes), 699
Factors' ('Iron Transport) An Absolute Requirement for, by *Microbacterium lacticum* 8181 (Dr D Hendlin and Dr A L Demain), 1894
Factors (Pathogenic), in the Rooting Space and the Development of Even-Aged Plantations (W R Day), B A 46
Factors (Selection), in a Tropical Trawl Fishery Prediction of (Alan R Longhurst), 1170
Fagnani, Prof G Alpine Mineral Fissures (Relationship of Alpine Fissure Minerals to those of the Druses in the Granite of Baveno), 1909
Fahey, John L , and Potter, Michael Bence Jones Proteinuria associated with a Transplantable Mouse Plasma-Cell Neoplasm, 654, *erratum*, 1108
Fahlen, Goran Rete Mirable in the Gas Bladder of *Coregonus lavaretus*, 1001
Fahmy, Dr Myrtle J (Fahmy, Dr O G , and) Complementation among the Sub-Genic Mutants in the *r*-Locus of *Drosophila melanogaster*, 1927
Fahmy, Dr O G , and Fahmy, Dr Myrtle J Complementation among the Sub-Genic Mutants in the *r*-Locus of *Drosophila melanogaster*, 1927
Fahraeus, G (Ljunggren, H , and) Effect of *Rhizobium* Polysaccharide on the Formation of Polygalacturonase in Lucerne and Clover, 1578
Failure of Corpuscles of Stannius from Winter Flounder (*Pseudopleuronectes americanus*) to Synthesize Adrenocorticosteroids *in vitro* (Dr J G Phillips and Dr P J Mulrow), 558
Failure to Recover infective 'Ribonucleic Acid' from Myxovirus Preparations (G L Ada, Patricia E Lind, Lois Larkin and Sir Macfarlane Burnet), 360
Fairbairn, J W (edited by) The Pharmacology of Plant Phenolics—Proceedings of a Symposium held at Oxford, 1958, *review* by Dr F A Robinson, 486
Fairbrother Dr F Appointed professor of inorganic chemistry in the University of Manchester, 1986
Faith of a Realist, *review* by F I G Rawlins, 388
Faktor, Dr M M (Bradley, Dr D C , and) Volatile Methoxides of Aluminium and Zirconium, 55
Falbe-Hansen, Dr I (Faber, Dr M , and) Nonhaem Iron in Erythrocytes as a Precusor for Haemoglobin, 1043
Falconer, I R Awarded a Wellcome Fellowship by the Animal Health Trust, 771
Falconer, I R (Robertson, Dr Hamish A , and) Accumulation of Radioactive Iodine in Thyroid Glands subsequent to Nuclear Weapon Tests and the Accident at Windscale, 1699
Falck, Dr Bengt Site of Production of Œstrogen in the Ovary of the Rat, 1082
Falk, Dr J E , and others Effect of Oxygen Tension on Haem and Porphyrin Biosynthesis, 1217
  Binding of Haem to Protein in Haemoglobin and Myoglobin, 1651
Falk, P Excursion Flora of the British Isles, *review*, 1093
Fall-Out Gamma-Radiation from Deposited (D H Peirson and L Salmon), 1678
Fallot, P , and others Low-Temperature Autoradiography for the Detection of Tritium in Tissue, with Removal of Luminescence induced by Tritium, 1385
Families of Flowering Plants (Dr J Hutchinson), second edition, Vol 1, Dicotyledons , Vol 2, Monocotyledons, *review* by Prof T G Tutin, 1759
Family in the Belgian Congo Haemoglobin *P* in a (Dr Paulette Dherte, Dr H Lehmann and Dr J Vandepitte), 1133
Fantola, A L , and others Rôle of Stroma in Haemoglobin Synthesis—Experiments on Duck Red Cells *in vitro*, 1878
  Pathway of Carbon-^{14} Incorporation from NAH^{14}CO$_3$ to Haem in Duck Blood incubated *in vitro*, 1879
Far East (Asia and the) School Meals in, 420
Far Side of the Moon Absence of Craters on the (David B Beard), 1631
Faraday Society Discussion on Energy Transfer with special reference to Biological Systems, 688
  Spiers Memorial Lecture (Prof Th Forster), 688
Faraday Society (British Society of Rheology and the Colloid and Biophysics sub-Committee of the) Discussion on Flow Properties of Blood and other Biological Systems, 322, 1539
Farkas, Adalbert (edited by) Advances in Catalysis and related Subjects, Vol 9, *review* by Dr E B Maxted, 750
Farkas, Dr G L , and others Biochemical Mechanism of Lesion Formation in Virus-infected Plant Tissues, 706
Farkas, M , and others Thermoregulatory Heat Production in the Brain, 993
Farm Sex on the, *review* by Dr S J Folley, 1091
Farm Crops Recognition of Diseases and Pests of (Ernst Gram, Prosper Bovien and Chr Stapel), *review* by F C Bawden, 1258
Farming (British) Balance in (Dr H G Sanders), B A 48
Farming (Lancashire Livestock), in the Great Depression (T W Fletcher), 1916
Fasciculus limpidus nov gen , nov spec , a Representative of a New Group of Bacteria (Prof E G Pringsheim), 1098
Fasciola hepatica Penetration of the Liver-fluke, into the Snail *Limnaea truncatula* (Dr Ben Dawes), 1334
Fast Abnormal Haemoglobin (New), in Newborn Nigerians (Dr A E Boyo and R G Hendrickse), 997
Fast Breeder Reactor, Dounreay Criticality of the, 1449
Fast Chemical Reactions in Solution (Deutsche Bunsengesellschaft fur Physikalische Chemie and the Max-Planck Gesellschaft Colloquium on), 1453
Fast-Moving γ-Globulins Separation of, by Starch-Gel Electrophoresis (Dr M D Poulik, Dr W W Zuelzer and Dr R Meyer), 1800
Fast Reactions in Solids (Dr F P Bowden and A D Yoffe), *review* by Dr Peter Gray, 664
Fasted Mice (Dehydrated and) Subcutaneous Absorption of Urethane in (Eigill Hvidberg and Jens Schou), 646
Fasted Rats Effect of Whole-body X-Irradiation on the Insulin Resistance of (Dr V Stankovic and N Sestan) 1816
Fat (Dietary), and Extent of Blood Sampling Effect of, on the Level of Plasma Cholesterol in the Rat (I Coleman and J M R Beveridge), 1039
Fat (Internal), 'Fill', and the Herbage Intake of Grazing Cattle A Relationship between Weight of (J C Tayler), 2021
Fat Body Cells (Frozen), in an Insect Survival of (R W Salt), 1426
Fat Content of Algal Cells Value of a Simple Observational Technique for Determining the (Dr J H Evans), 1737
Fat Oxidation and Haematin Systems in Cheese (Tallowy Discoloration in Cheddar Cheese), (C G Rammell), 1296
Fat Oxidation and Trace Metals in Cheese (Tallowy Discoloration in Cheddar Cheese), (F Bishop), 1295
Fat-free Carcasses and Bodies of New Zealand Sheep Composition of some (A H Kirton, M J Ulyatt and R A Barton), 1724

Fate of the Highly Polymerized Spleen Deoxyribonucleic Acid labelled with Phosphorus-32 Injected Intraperitoneally into Rats (Tamara A Hudnik-Plevnik, Vladimir R Glišin and Marta M Simic), 1818
Fate of Injected Dextran Labelled with Tritium in Mice (Å Hanngren, E Hansson, S Ullberg and Prof B Åberg), 373
Fate of Intravenously Administered Lactose Labelled with Carbon-14 Preliminary Observations on the (Dr Frederick J Carleton and Dr Henry R Roberts), 1650
Fate of Subcutaneous Thymus Grafts in Thymectomized Mice Inoculated with Leukaemic Filtrate (J F A P Miller), 1809
Fatigue Metal (edited by Dr J A Pope), *review* by Dr K M Entwistle, 1438
Fatigue of Welded Structures (British Welding Research Association and the Engineering Department of the University of Cambridge, Symposium on), 1915
Fatigue Life of Steel (Aerobic Corrosion) Relationship of *p*H to (Dr Frederick J Radd, L Hugh Crowder and Louis H Wolfe), 2008
Fatigue-Induced After-Effect in Zinc Single Crystals (A H Meleka and G B Dunn), 896
Fats (Depot), of Ruminants and Non-Ruminants Trans-Unsaturated Acids in the (L Hartman and Dr F B Shorland), 2024
Fatty Acid (Volatile) Relationship between *p*H and, and Diversion of Saliva from the Actively Fermenting Rumen of Sheep (W R McManus), 1572
Fatty Acid Methyl Esters (Long-Chain) Gas Chromatographic Separation of, on Polyvinyl Acetate (Irwin Hornstein, L E Elliott and P F Crowe), 1710
Fatty Acids of Olive Oil Quantitative Estimation of the (J Gracian, E Vioque and Mª Pilar de la Maza), 1941
Fatty Acids (Non-Esterified) Release of, from Adipose Tissue in Normal and Diabetic Rats (Dr J Wenkeova and Dr J Pav), 1147
Fatty Acids (Odd-Numbered Carbon), from Propionate Production of, by Mice (Prof S B Tove), 1647
Fatty Alcohols with Plant-Growth Promoting Activity Isolation of, from Maryland Mammoth Tobacco (Dr A J Vlitos and Dr D G Crosby), 462
Faulkner, E A Quadrupole Anti-Shielding Factor in Copper, 442
Fauna of Netherlands New Guinea, *review* by J E Hill, 1261
Fauna (Deep Sea) Palaeotemperatures and the Origin of the, 1025
Fauna (Indian Termite) New Neotropical Element (*Anoplotermes*) in (Dr M L Roonwal and O B Chhotani), 1967
Fauna (Molluscan), of the Netherlands, 1612
Fauna (Neotropischen) Beiträge zur (herausgegeben von Prof Dr Erich Titschack und Dr Hans-Wilhelm Koepcke), Band I, Heft 3, Zur Kenntnis der Pseudoscorpioniden-Fauna des Andengebietes (Max Beier) , Kritische Untersuchungen der Newportia-Arten (Wolfgang Bucherl) , Ein neuer *Asthenes* (Aves, Furnariidae) von der Kuste und dem westlichen Andenabhang Sudperus (Maria Koepcke) , Beitrage zur Kenntnis der Fische Perus, II (Hans-Wilhelm Koepcke), *review* by Dr F A Turk, 1177
Fauna (Palearctic) The Birds of the—Order Passeriformes (Dr Charles Vaurie), *review* by Sir Landsborough Thomson, 666
Fauna (Relict), of Ennerdale Water—a Problem of Distribution (Dr W Pennington), 1421
Fauna (World's) Man and the (Dr L Harrison Matthews), B A 43
Faune de France Vol 62, Coleopteres Curculionides, troisieme partie (Adolphe Hoffmann), *review* by R T Thompson, 573
Favarger, C Origin and Dispersal of Flowering Plants (Incidence of Polyploidy in Switzerland in certain Alpine Groups coincided with a Floristic Subdivision), 1200
Fawcett Dr C H Plant-Growth Substances and the Copper Chelating Theory of the Mode of Action, 796
Fawcett, Dr C H , and others Plant Growth Regulation (Metabolism of Indole Auxins in Plants), 599
Fazakerley, S , and others Preparation of Crystalline *trans-trans* Methyl Linoleate Hydroperoxide, 816
Feather, Prof Norman The Life of Frederick Soddy, *review*, 298
  Obituary of Prof C T R Wilson, 1842
Fedden, R Romilly The Country House and the Museum, 598
Feder, William A (Everard, C O R , and) Effective Increase in Nematode Populations by the Addition of Aureomycin, 1887
Federation of British Industries Forty-second Annual Report (1958), 94
Federation of British Industries (Liverpool District) Conference on the Relationship between Industry and Technical Colleges, 1690
Fedorenko, N V Ionization Phenomena in Gases (Results of Measurement on Electron-capture by Multiply Charged Ions), 1354 (Ionization of Inert Gases by Protons), 1354
Feeding of a Ctenophore, *Bolinopsis infundibulum* (O F Muller), (A K Nagabhushanam), 829
Feeding the Hungry (Gerard Piel), 162
Feeding (Selective), in Female *Callihpora erythrocephala* Meig Hormonal Control of (J Strangways-Dixon), 2040
Feeding Mechanism of *Tilapia nigra* (Peter J Whitehead), 1509
Feeding (Force-) Fish under Experimental Conditions (Dr J M Dodd, Dr M H I Dodd and Dr C K Goddard), 1660
Feibelman, W A Geophysical Effects of High-Altitude Nuclear Explosions, 442
Feinberg, J G (Turner, E G , and) Retentate, a New Scientific Term, 1139
Fellgett, Dr Peter, and others Fluctuations in Photon Streams, 967
Fellowship Vitamealo (Animal Health Trust Award), 771
Fellowship to honour the visit of H M the Queen and H R H the Duke of Edinburgh (International Nickel Company of Canada, Ltd), 772
Fellowship (Perkin Centenary), awarded to Brian Whitear, 237
Fellowships for 1960-61 (Ciba Fellowship Trust), 1613
Fellowships Harkness (Commonwealth Fund), 857
  Mond Nickel, 1272
  Postdoctoral (United States National Science Foundation), 1534
  Wellcome (Animal Health Trust Awards for 1959-60), 771
Fellowships in Chemistry New Awards for 1959-60 (Ramsay Memorial Fellowships Trustees), B A 16
Fellowships (Travelling Research) Carlsberg–Wellcome (Awards), 683
Felsenfeld, Dr G (Bradley, Dr D F , and) Aggregation of an Acridine Dye on Native and Denatured Deoxyribonucleates, 1920
Feltmaking Research, 320
Female *Calliphora erythrocephala* Meig Hormonal Control of Selective Feeding in (J Strangways-Dixon), 2040
Female-sterile Flowers in *Fuchsia* (M Holdsworth), 1024
Fencing Posts in Australia (Commonwealth Scientific and Industrial Research Organization, Australia, Rural Research, 27), 321
Fencl, V , and others Haemodynamics in Essential Hypertension, 1643
Fenton, G W (Wandless, A M , and) Coal Science (Carbonization—Coking Tests on Coals of 84, 85 and 87 per cent Carbon Content), 413
Ferguson, Dr J At the Second Australian Spectroscopy Conference (Polarized Spectra of Microcrystals of some Cobalt (II) Tetrahedral and Octahedral Complexes), 1196
Ferguson, K A Influence of Dietary Protein Percentage on Growth of Wool, 907
Ferguson, T B Appointed a lecturer in mechanical engineering at the University of Sheffield, 684
Fermenting Rumen (Actively), of Sheep Relationship between *p*H and Volatile Fatty Acid and Diversion of Saliva from the (W R McManus), 1572
Fern Species *Anemia phyllitides* Control of Antheridium Formation in the (Dr Ulrich Näf), 798
Fernandez, E , and others A Lesion of the Follicle and of the Fibre of Wool and its Possible Relation with an Excess of Iron in the Forage, 559
Fernandez-Gimeno, Martha A , and others The C_{17}-OH Group of Œstradiol—Relationships between its Anti-Atherogenic and Endocrine Actions, 1720
Ferns (Polypodiaceous) Deoxyribonucleic Acid in Eggs of the (Dr P R Bell), 1664
Ferrando, Prof R , and others A Method of Increasing the Phosphorus Content of Forages, 76
Ferrari, Prov W , and others Increase by Chlorothiazide of the Paralysing Activity of *d*-Tubocurarine Chloride, 1235
Ferraro, Prof V C A Thermonuclear Research (Current-bearing Streams from the Sun), 1017
  Magnetohydrodynamics, *review*, 1672
Ferret Pituitary Gland A Nucleus of Nerve Cells in the (Dr R L Holmes), 1819
Ferri, A Basic Problems in Propulsion (Composite Launchers), 779
Ferric Salts Oxidation of Ethyl Alcohol by a Mixture of Hydrogen Peroxide and (Dr Mordechai L Kremer), 720
Ferrichrome Compounds The Iron-Binding Centre of (Dr T Emery and Dr J B Neilands), 1632
Ferricretes Pleistocene Climatic Significance of Calcretes and (Dr R J Mason, A B A Brink and K Knight), 568
Ferritin (Circulating) Pathophysiological Effects of (Yoshio Oki), 1944
Ferroelectricity, *review* by Dr L E Cross, 6
Ferroelectricity in Crystals (Dr Helen D Megaw), *review* by Dr L E Cross, 6
Fertility Current Research on Reproduction and, *review* by Dr T Mann, 1434
  Studies on, including Papers read at the Conference of the Society for the Study of Fertility, London 1958 (edited by Prof R G Harrison), *review* by Dr T Mann, 1434
Fertility Society for the Study of Proceedings, Vol 10, Studies on Fertility including papers read at the Conference, London 1958 (edited by Prof R G Harrison), *review* by Dr T Mann, 1434
Fertility in a Normal American Population An Association between Abo Blood Groups and (Dr T Edward Reed and Dr J H Ahronheim), 611
Fertility (Low Soil) Adaptation of a Lead-tolerant Population of *Agrostis tenuis* to (D Jowett), 43
Fertility (Marital), in England and Wales (Prof E Grebenik), 1035
Fertility Factor in *Salmonella typhimurium* (T Miyake), 657
Fertility Report (Census 1951, England and Wales), 1035
Fertilization of Rabbit Ova *in vitro* (Dr M C Chang), 466
Festschrift for R E Snodgrass, 591
Few-Nucleon Problem International Conference on Nuclear Forces and the (Dr T C Griffith and E A Power), 1113
Feynman, Dr Richard P Appointed to the Tolman chair of theoretical physics in the California Institute of Technology, 768 , work of, 768
Fibre of Wool A Lesion of the Follicle and of the, and its Possible Relation with an Excess of Iron in the Forage (Prof G Gonzelez, J Garcia and E Fernandez), 559
Fibre Optics (High-Resolution), using Sub-Micron Multiple Fibres (Dr N S Kapany), 881
Fibre Surface Replication by Rolling (J Mølgaard), 264, 1478 , (H J Woods), 1478
Fibres Biological (X-Ray Analysis Group of the Institute of Physics Conference on), B A 25
Fibres (Atrophic Muscle) Dissociation of the 'Surface Membrane Complex' in (Dr R Birks Prof B Katz and Dr R Miledi), 1507
Fibres (Cellulosic) A Special Case of the Superposition of Crystal Plates between Crossed Polars and its Bearing on the Microscopy of (Dr N H Hartshorne), 179
Fibres (Glass) Strength of (J G Morley), 1560
Fibres (Glycerol-extracted Muscle) Oxygen Uptake of (James A Wilson Paul R Elliott, Prof Karl F Guthe and David G Shappirio), 1947
Fibres (Mucosal Nerve) Are, Essential for the Peristaltic Reflex? (Dr K H Ginzel), 1235
Fibres (Papermaking) Fundamentals of—Transactions of the Symposium held at Cambridge, 1957 (edited by Francis Bolam), *review* by Dr Julius Grant, 1011
Fibres (Sub-Micron Multiple) High-Resolution Fibre Optics using (Dr N S Kapany), 881
Fibrillar Polysaccharides Liquid Crystal Systems from (R H Marchessault, F F Morehead and N M Walter), 632
Fibrinolysin Lability of (Prof Murray Weiner), 1937
Fibrinolysis (Urokinase-Induced), of Human Standard Clots (Dr Kuro N von Kaulla), 1320
Field, Dr Paul, and others Establishment of Parenchymatous Spleno-Pulmonary Venous Anastomosis, 703
Field *Sporidesmium bakeri* and Facial Eczema of Sheep in the (R H Thornton and D P Sinclair), 1327
Field Corn (*Zea mays* L) in Canada Isolation of the Antifungal Substance, 6-Methoxybenzoxazolinone, from (N J Whitney and C G Mortimore), 1320

Field Effects on Chemisorbed Films in Electron Emission Microscopy (R J Hill and P W M Jacobs), 895
Field Museum of Natural History Botanical Series, Vol 13, Part 4, No 2, Flora of Peru (Rogers McVaugh), *review*, 666
Field Strength (Sky Wave), in Tropical Regions The Calculation of the Median (W R Piggott), 605
Field-Strengths (Radio), in the Tropics, 605
Field Studies, Vol 1, No 1 (Field Studies Council) ,1533
Field Studies Council *Field Studies*, Vol 1, No 1, 1533
Fields, P R , *et al* Research on Element 102 (Nobelium), 507
Fifty Years of the School Health Service The Health of the School Child—(Report of the Chief Medical Officer of the Ministry of Education for 1956 and 1957), 98
Filament Contractile Mechanism (Sliding), in Tonic Smooth Muscles of Lamellibranch Molluscs Evidence for a (Dr Jean Hanson and Dr J Lowy), 286
Filamentous Mould *Penicillium chrysogenum* and the Control of its Morphology Continuous-Flow Culture of the (S J Pirt and D S Callow), 307
Filaments (Microbiological), in Soils Occurrence of (Roy D Bond), 744
Filarski, Dr J Polar Front Survey (Hydrography—North Sea), 1183
'Fill', (Internal Fat,) and the Herbage Intake of Grazing Cattle A Relationship between Weight of (J C Tayler), 2021
Film (Transparent Cellulose) Use of, for Roller Tube Tissue Cultures (John A Sharp), 1508
Film Council, British Universities Twelfth Annual General Meeting (Dr J Horne), 330
  Discussion on the Visual Illustration of University Lectures, 515
Film Research (Instructional), in Pennsylvania (C Denis Pegge), 866
Film Thickness Measurement by Beam Interferometry Substrate Damage in (Prof G David Scott), 354
Films (British Books and) Distribution of, Overseas, 1448
Films (Chemistry) Index of (Royal Institute of Chemistry), *review* 1902
Films (Chemisorbed), in Electron Emission Microscopy Field Effects on (R J Hill and P W M Jacobs), 895
Films (Interlamellar) Phase Transitions in (Dr D M C MacEwan and Dr F Aragon de la Cruz), 1859
Filmstrips for Schools, 1777
Filson, A , and others Action of Mixed Solvents on Wool, 444
Filter (Continually Renewable) A Partial Chemical Characterization of Maize Coleoptile Cell Walls prepared with the Aid of a (Prof Aleksander Kivilaan, Teofila C Beaman and Robert S Bandurski), B A 81
Filters (Cellulose Membrane) Relation of Invasive Capacity to Passage of Lymphocytic Cells through (Dr Emma Shelton and Dr Mary E Rice), 479
Filtrate (Leukaemic) Fate of Subcutaneous Thymus Grafts in Thymectomized Mice Inoculated with (J F A P Miller), 1809
Filtration (Gel), as a Method for Purification of Protein-bound Peptides as exemplified by Oxytocin and Vasopressin (E B Lindner, Dr A Elmqvist and Dr J Porath), 1565
Finan, Dr P A , and Reed, Dr R I Application of the Mass Spectrometer to Polysaccharide Chemistry, 1866
Finance Museums and (Museums Association Discussion on), 598
Financial Structure of the Colonial Development Corporation Report of the Committee of Enquiry into the, 1520
Finch, D Studies of Coal—Smoke Emission from Coal and Low-Temperature Chars, 426
Finder' The 'England (Graticules, Ltd), 34
Fine, Dr J M (Moullec, Dr J , and) Frequencies of the Haptoglobin Groups in 406 French Blood Donors, 196
Fine, Dr J M , and others Modifications in Immunological Behaviour, Electrophoretic Mobility and Colourability of Substituted Human Serum Proteins, 1571
Fine Structure in Cells of Pea and Wheat Embryos (G Setterfield, H Stern and F B Johnston), 505
Fina Structure of Enhanced Solar Radio Radiation Observations of the, with a Narrow-Band Spectrum Analyser (Oystein Elgaroy), 887
Fine Structure in Muscle Ionic Partition and (Dr Shirley E Simon), 1978
Finney, Dr D J The Fundamentals of Statistical Reasoning, *review*, 217
Fire Research The Use of Models in (Committee on Fire Research and the Fire Research Conference of the Division of Engineering and Industrial Research of the United States National Academy of Sciences–National Research Council Symposium on), 772
First Abyssal Priapulid *Priapulus abyssorum*, New Species, the (Robert J Menzies), 1585
First Atomic Merchant Ship, B A 15
First Minister for Science (Rt Hon Viscount Hailsham), 1263
Firth, Shaun Science by the Upper Form (The Sedges of Askham Bog), 597
Fische Perus, II Beitrage zur Kenntnis der (Dr Hans-Wilhelm Koepcke), (Beitrage zur Neotropischen Fauna), *review* by Dr F A Turk, 1177
Fischer, Dr Heinz, and Mansur, Lawrence C (edited by) Conference on Extremely High Temperatures (sponsored by the Electronics Research Directorate of the United States Air Force Cambridge Research Center, Boston, 1958), *review* by Dr T E Allibone, 83
Fiset, Paul (James, Suzanne M , and) Serum Inhibitors of Asian Strains of Influenza Virus, 1656
Fish Force-Feeding, under Experimental Conditions (Dr J M Dodd, Dr M H I Dodd and Dr C K Goddard), 1660
  Multiple Haemoglobins in (Dr N Chandrasekhar), 1652
Fish (Freeze-dried Pork and) Absorption of Atmospheric Moisture by (Norman A Matheson), 1949
Fish (Zebra) Variations in Early Cleavage of the (A W Marrable), 1160
Fish Liver Oils Isomers of Vitamin A in (Patricia S Brown, William P Blum and Max H Stern), 1377
Fish Mucus Species Specificity of (J M Barry and Prof Fergus J O'Fourke), 2039
Fish and Frog Neurohypophysial Extracts Chromatographic and Biological Characteristics of (Active Principles of the Neurohypophysis of Cold-blooded Vertebrates), (B T Pickering and Prof H Heller), 1463
Fisher, E W , and Dalton, R G Cardiac Output in Horses, 2020
Fisher, Dr M E Fluctuation Phenomena and Stochastic Processes (Shapes and Sizes of Polymer and Polyelectrolyte Molecules which seriously affected Properties like Viscosity), 510
Fisher, Dr Myron W , and others An Experimental Enterococcal Pyelonephritis in Mice, 561
Fisheries Research (Sea), in East Africa, 855
Fishery Research (J H S Blaxter) 865
Fishery (Tropical Trawl) Prediction of Selection Factors in a (Alan R Longhurst), 1170
Fishes Development of the Yolk Nucleus in the Oocytes of some (Prof A Stolk), 1746
  A Ligament in the Dorsal Aorta of certain (Dr L L de Kock and Dr S Symmons), 194
  Studies on Social Groupings in (Dr C M Breder, Jr), 865
  Urethane as a Carcinogen and as an Anaesthetic for (Dr J N Ball and Prof P N Cowen), 370
Fishman, Prof William H , and others Liver Glucosyl Oligosaccharides and Glycogen—Carbon-14 Dioxide Experiments with Hydrocortisone, 1380
Fission (Triple), of Uranium-235 Two Cases of (J Catala, J Casanova and V Domingo), 1057
Fission Products Biogeochemical Enrichment of (Prof Pontus Ljunggren), 912
Fissures Alpine Mineral (International Mineralogical Association Symposium on), 1909
Fistulae (Bile) Thirst for Bile in Rats with (Dr Albert J Bertinchamps, James J Greenough and George C Cotzias), 1405
Fitch, R K , and others Ionization Phenomena in Gases (State of the Cathode on Growth Times and Sparking Potentials in Hydrogen), 1354
Fite, W L Ionization Phenomena in Gases (Recent Advances in the Study of Collision Processes in Gases), 1353
Fitter, R S R A New Service for Naturalists, 1774
Fitting the Job to the Worker, a Survey of American and European Working Conditions in Industry (European Productivity Agency of the Organization for European Economic Co-operation, Project 335), 422
Fixation of Nitrogen by the Rice Plant (S P Chakraborty and S P Sen Gupta), 2033
Fixation (Nitrogen), in a Uganda Swamp Soil (E A Calder), 746
Fixation (Non-Symbiotic Nitrogen), in a Soil of the Nigerian Rain-Forest Zone (Dr A W Moore and J N Abaelu), 75
Fixation (Paraffin-Oil) Paper Electrophoretic Patterns obtained by (H Waldmann-Meyer), 1567
Fixation (Symbiotic Nitrogen), of Legumes Influence of Temperature on the (the late Prof Margaretha G Mes), 2032
Flagellar Protein (Bacterial) ε-N-Methyllysine in (R P Ambler and M W Rees), 56
Flagellates Photoreactive Pigments in—Chromoprotein Pigments of some Cryptomonad Flagellates (Dr Mary Belle Allen, Dr Ellsworth C Dougherty and Dr John J A McLaughlin), 1047 , Phycoerythrins and Phycocyanins of Cryptomonads (Dr C OhEocha and M Raftery), 1049 , Photosynthetically Active Accessory Pigments of Cryptomonads (Dr F T Haxo and D C Fork), 1051
Flagellates (Cryptomonad) Chromoprotein Pigments of some (Photoreactive Pigments in Flagellates), (Dr Mary Belle Allen, Dr Ellsworth C Dougherty and Dr John J A McLaughlin), 1047
Flagrantes da Vida na Lunda (Introducao de Dr José Osorio de Oliveira), (Companhia de Diamantes de Angola, Museu fo Dundo, Publicacoes Culturais No 37), 236
Flare (Solar) Magnetic Field associated with a Great (Dr Robert Howard, Dr Thomas Cragg and Dr Horace W Babcock), 351
Flares on the Solar Disk Associated with Noise Distribution of (L R McNarry), 806
Flares (Solar) Association of Radio Outbursts with (L D de Feiter, A D Fokker and J Roosen), 805
  Rocket Studies of Emissions caused by (United States National Science Foundation Grant), 406
Flash Technique Primary Processes indicated by the (Reductive Photobleaching of Eosine), (Shunji Kato and Masao Koizumi), 1620
Flavin Adenine Dinucleotide Binding of the Sulphydryl Group in D-Amino-Acid Oxidase Apo-Protein with (Dr Kunio Yagi and Takayuki Ozawa), 1227
  Change of Absorption Spectrum of, by its Binding with both D-Amino Acid Oxidase Apo-Protein and Benzoate (Dr Kunio Yagi, Takayuki Ozawa and Minoru Harada), 1938
Flavins Complex Formation of Chlorpromazine with (Dr Kunio Yagi, Takayuki Ozawa and Toshiharu Nagatsu), 982
  Effect of, on Cramp caused by Phenol (Dr Kunio Yagi, Dr Hirofumi Yagi and Dr Ikuko Nagatsu), 1648
Flavins as Components of Folic Acid Reductases (Dr Beatriz M Braganca and U W Kenkare), 1488
Flavones N-Substituted 7-Methoxy-8-Aminomethylchromones and—New Brain-Stem Stimulants (P Da Re, L Verlicchi, Dr I Setnikar, W Murmann and M J Magistretti), 362
Fleck, Sir Alexander New Research Laboratories of the British Non-Ferrous Metals Research Association opened by, 234, 242
Fleming, N , and Robinson, D W Recent Studies of Noise Problems (Human Response to Noise—Evaluation of the Loudness of a Complex Sound), 414
Flesher, Dr Anna M , and others Prophylactic Effects of Amine Oxides in Radiation Injury in Mice, 198
Fletcher, T W Lancashire Livestock Farming in the Great Depression, 1916
Fletcher, Dr Wm W , and others Gibberellic Acid and Nodulation of Legumes, 1576
Flett, Dr T M Appointed to a senior lectureship in pure mathematics in the University of Liverpool, 410
Flexner (Abraham) Lectures of Vanderbilt University, 1958 (Sir Macfarlane Burnet), *review* by Dr J H Humphrey, 753
Flies Plastron Respiration in the Eggs of *Drosophila* and other (Dr H E Hinton), 280
Flies (House-) Mechanisms of Resistance of Adult, to the Insecticide Dieldrin (F P W Winteringham and A Harrison), 608
  Pentachloro*cyclo*hexane as a Possible Intermediate Metabolite of Benzene Hexachloride in (R G Bridges), 1337
  Resistance of, to γ-Benzene Hexachloride and Dieldrin (R G Bridges and J T Cox), 1740

Flight Behaviour in Conventional and Extra-Terrestrial (Air Commodore W K Stewart), 578
  The Story of (Victor Wall), 1535
Flight (Space) Russian View of, *review* by D G King-Hele, 836
Flight Exercise Release by, of a Chemotropic Response from Photopositive Domination in a Scolytid Beetle (Prof Kenneth Graham), 283
Floating (Free-) Marine Red Alga (Dr H B S Womersley and Dr R E Norris), 828
Floating-zone Melting (Electron Bombardment), and Allied Electron Bombardment Techniques (Services Electronics Research Laboratory Symposium on), 690
Flood Tide Discrimination between Ebb and, in Migrating Elvers (*Anguilla vulgaris* Turt) by means of Olfactory Perception (F Creutzberg), 1961
Flora Circumpolar Arctic (Dr Nicholas Polunin), *review* by R D Meikle, 1347
Flora of the Arctic, *review* by R D Meikle, 1347
Flora of Guatemala (Paul C Standley and Julian A Steyermark), 771
Flora of Peru (Rogers McVaugh), *review*, 666
Flora of Tropical East Africa—Leguminosae subfamily Mimosoideae (J P M Brenan), 409
Flora (Excursion), of the British Isles (Prof A R Clapham, Prof T G Tutin and Dr E F Warburg), *review* by P Falk, 1093
Floral Abnormalities in Broccoli (D R Sampson and M MacArthur), 682
Floral Initiation and its Relationship to Growth-Stage in Red Clover (*Trifolium pratense* L), (J L Stoddart), 559
Floral Malformation in *Panicum antidotale* caused by a Species of *Eriophyses* (Dr V M Desai and Dr M J Thirumalachar), 1586
Floral Morphology and the Taxonomy of Eucalyptus (Dr D J Carr and S G M Carr), 1549
Flore Afrique Tropicale, Association pour l'Étude Taxonomique de la Vegetation Map of Africa (Explanatory Notes by R W J Keay with a French translation by A Aubreville), 594
Floristic Studies New, 409
Flotation (Ion) Concentration by (Prof F Sebba), 1062
Flounder (Winter), *Pseudopleuronectes americanus* Failure of Corpuscles of Stannius from, to Synthesize Adrenocorticosteroids *in vitro* (Dr J G Phillips and Dr P J Mulrow), 558
Flour (Wheaten) Extraction of the Total Protein from, in the Form of Soluble Derivatives (E E McDermott and Dr J Pace), 546
Flow of Blood through Narrow Tubes (Prof M Reiner and Dr G W Scott Blair), 354
Flow of Compressible Fluids, *review* by Dr W P Jones, 485
Flow through Porous Media Sedimentation Rates, Fluidization and (Colin C Harris), 716
Flow in Vascular Beds Resistance to (Harris S Burry), 453
Flow Properties of Blood and other Biological Systems (British Society of Rheology and the Colloid and Biophysics sub-Committee of the Faraday Society Discussion on), 322, 1539
Flow (Compressible Fluid) Mathematical Theory of (Richard von Mises), (completed by Hilda Geiringer and G S S Ludford), *review* by Dr W P Jones, 485
Flow (Continuous-) Culture of the Filamentous Mould *Penicillium chrysogenum* and the Control of its Morphology (S J Pirt and D S Callow), 307
Flow (Renal Blood) Mechanism of Autoregulation of (Dr Allen M Scher), 1322
Flow (River), in Great Britain (F W H Green), 210
Flower Petals of *Adonis annua* L Occurrence of Astaxanthin in the (A Seybold and Prof T W Goodwin), 1714
Flowering in Birch Seedlings Early Induction of (Dr K A Longman and Prof P F Wareing), 2037
Flowering and Fruit Set in Sweet Potato Effect of Indole Acetic Acid and α-Naphthalene Acetic Acid on the Growth, (G Satyanarayana and Dr G Rangaswami), B A 73
Flowering, Nodulation and Nitrogen Assimilation of *Vicia villosa* Influence of Gibberellic Acid and Photoperiod on the Growth, (the late Prof Margaretha G Mes), 2035
Flowering Plants The Families of (Dr J Hutchinson), second edition, Vol 1, Dicotyledons , Vol 2, Monocotyledons, *review* by Prof T G Tutin, 1759
  Origin and Dispersal of (Prof A S Boughey), 1200
Flowers (Female-sterile), in *Fuchsia* (M Holdsworth), 1024
Flowers and Ovaries (Inflorescences,), of an Apomict, *Aerva tomentosa* Forsk *In vitro* Culture of the (Prem Murgai), 72
Flowers and Runners in the Strawberry Effect of Gibberellic Acid on the Initiation of (P A Thompson and C G Guttridge), B A 72
Floyd, Dr W F Ergonomics, its Place in Industry, B A 20
Fluctuation Phenomena in Semi-Conductors (Prof A Van der Ziel), *review* by Dr R A Hyman, 1754
Fluctuation Phenomena and Stochastic Processes (Physical Society Conference on), 509
Fluctuations in Photon Streams (Dr Peter Fellgett, Dr R Clark Jones and Dr R Q Twiss), 967 , (Dr C W McCombie), 969
Fluctuations (Current), in the Oxide Cathode (Margaret Chisholm and Dr L Jacob), 1058
Flugge, S (herausgegeben von) Handbuch der Physik, Band 50, Astrophysik I, Sternoberflachen-Doppelsterne, *review* by Prof R O Redman, B A 3
Fluid Flow (Compressible) Mathematical Theory of (Richard von Mises), (completed by Hilda Geiringer and G S S Ludford), *review* by Dr W P Jones, 485
Fluid Systems, *review* by Prof J M Coulson, 132
Fluidization and Flow through Porous Media Sedimentation Rates, (Colin C Harris), 716
Fluids (Compressible) Flow of, *review* by Dr W P Jones, 485
Fluorescence Changes in, in a Frog Sartorius Muscle following a Twitch (Prof Britton Chance and Frans Jobsis), 195
Fluorescence Measurements of Mitochondrial Pyridine Nucleotide in Aerobiosis and Anaerobiosis (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Prof Britton Chance and Dr Bo Thorell), 931
Fluorescent Schiff-Type Reagents for Cytochemical Detection of Polyaldehyde Moieties in Sections and Smears (Prof Frederick H Kasten, Vivian Burton and Peggy Glover), 1797
Fluorescent Substance (Red), in the Urine of Pyridoxine-deficient Rats 8-Hydroxyquinaldic Acid, the (Dr J K Roy, Dr R R Brown and Prof J M Price), 1573
Fluorescent Thyroid-stimulating Hormone in Rat Tissues Histological Localization of (Dr E E Mancini, O Vilar, J M Dellacha, A Gimeno and A Castro), 1733
5-Fluorouracil Massive Incorporation of, into a Bacterial Ribonucleic Acid (Dr Jack Horowitz and Prof Erwin Chargaff), 1213
Flux, J E C At the Conference of the Mammal Society of the British Isles (Colour Change in Wild Specimens of the Mountain Hare in Aberdeenshire), 30
Fluxes (Salicylate and Potassium), of Rat Diaphragm (Dr J A Hicklin), 2029
Fly (House-) Esterase Inhibition and Organophosphorus Poisoning in the (Dr D Stegwee), 1253
Fly (House) Reproduction Role of Cholesterol in (Ronald E Monroe), 1513
Fly (Tsetse) Tissue Culture Development of *Trypanosoma vivax* to the Infective Stage in (Dr William Trager), B A 30
Foard, Donald E Pattern and Control of Sclereid Formation in the Leaf of *Camellia japonica*, 1663
Fodder Beet, Mangels and Swedes (National Institute of Agricultural Botany Leaflets on), 1777
Foetal Development Prevention of, by Enzyme Inhibition (Prof G Kahlson and Elsa Rosengren), 1238
Foetal Haemoglobin Estimation of Small Percentages of (Prof K Betke, H R Marti and I Schlicht), 1877
Foetal Haemoglobin in the Monkey (Dr G H Beaven and W B Gratzer), 1730
Foetal Haemoglobin without α-Chains Haemoglobin 'Bart's', a (Abnormal Human Haemoglobins), (Dr J A Hunt and Dr H Lehmann), 872
Foetal Haemoglobin (Human) Heterogeneity of—Incidence of Foetal Variants in Singapore (Dr F Vella), 272
Foetal Human Haemoglobin (Adult and) Serological Distinction of (G R E Naylor and M E Adair), 1854
Foetal Liver Relative Rates of Exchange of Potassium-42 by the Foetal Metanephros and (Dr J G Bearn and Dr F T C Harris), 1959
Foetal Metanephros and Foetal Liver Relative Rates of Exchange of Potassium-42 by the (Dr J G Bearn and Dr F T C Harris), 1959
Foetal Variants in Singapore Heterogeneity of Human Foetal Haemoglobin—Incidence of (Dr F Vella), 272
Foetal and Adult Sheep Inositol Concentration in the Cerebrospinal and Ocular Fluids and Tissues of the (D A Nixon), 906
Fokker, A D , and others Association of Radio Outbursts with Solar Flares, 805
Foliar Applications of its Salts on Apple Role of the Anion in Magnesium Uptake from (M Allen), 995
Folic Acid Reductases Flavins as Components of (Dr Beatriz M Braganca and U W Kenkare), 1488
Folley, Dr S J Sex on the Farm, *review*, 1091
Follicle and of the Fibre of Wool A Lesion of the, and its Possible Relation with an Excess of Iron in the Forage (Prof G Gonzelez, J Garcia and E Ferdendez), 559
Following Vivyl Polymerizations initiated by γ-Rays A Capacitance Method for (G J K Acres and F L Dalton), 335
Folsch, G , and others Action of Trypsin on α-Carbethoxy-L-lysyl-L-serylglycine and its O-Phosphorylated Analogue, 187
Fondation Universitaire, Bruxelles Rapport Annuel (1957-1958), 939
Food The Englishman's (the late Sir Jack Drummond and Anne Wilbraham), revised by Dorothy Hollingsworth, *review* by Dr Leslie J Harris, 484
Food for Survival after a Disaster (Dr R C Hutchinson), *review* by M W Grant, 841
Food Analysis, *review* by Dr V H Booth, 1347
Food Industry Enzymes in the (Food Group of the Society of Chemical Industry Symposium on), 1366
Food Manufacturing Industries Research Association, British Open Days (Prof B R Knapp), 1275
Food Products The Chemical Analysis of Foods and (Dr Morris B Jacobs), third edition, *review* by Dr V H Booth, 1347
Food Storage Infestation Control, a Service to Agriculture and (Ministry of Agriculture, Fisheries and Food), 941
Food and Agriculture, Ministry of (Government of India), and others Course on the Use of Radioisotopes in Agricultural Research, 1451
Food and Agriculture Organization (United Nations) Report of the Food and Agriculture Organization Nutrition Meeting in Europe, Rome, 1958, 407
  World Meeting on Veterinary Education, 943
Food and Agriculture Organization (United Nations), and others Course on the Use of Radioisotopes in Agricultural Research, 1451
Food and Agriculture Organization and the World Health Organization (United Nations) School-Feeding Seminar for countries in South and East Asia, 420
Foods and Food Products The Chemical Analysis of (Dr Morris B Jacobs), third edition, *review* by Dr V H Booth, 1347
Foot-and-Mouth Disease Effect of Proflavine on the Formation of the Virus of, and its Infective Ribonucleic Acid in Pig Kidney Tissue Culture Monolayers (F Brown and Doreen L Stewart), B A 74
Forage A Lesion of the Follicle and of the Fibre of Wool and its Possible Relation with an Excess of Iron in the (Prof G Gonzelez, J Garcia and E Fernandez), 559
Forages A Method of Increasing the Phosphorus Content of (Prof R Ferrando, S Metivier and R Gervy), 76
Foraminifera of the Oligocene of Belgium (D A J Batjes), 321
Forbes, Prof R J Man the Maker—a History of Technology and Engineering, *review* by Dr A R Hall, 921
Forbes, Dr R M (McAleese, Dr D M , and) Experimental Production of Magnesium Deficiency in Lambs on a Diet containing Roughage, 2025
Forbush Decrease Evidence for Cosmic Ray Energy Spectrum Changes during a (K W Ogilvie and M M Winn), 888
Force-Feeding Fish under Experimental Conditions (Dr J M Dodd, Dr M H I Dodd and Dr C K Goddard) 1660
Forces between Titanium Dioxide Pigment Particles (James E Latty and Dr W C Clark), 49
Forces (Swelling), in Straining Clays (E L Greacen), 1695

Ford, Prof P Title of professor emeritus conferred on, by the University of Southampton, 595
Forecasting Locust Outbreaks (Dr D L Gunn and P M Symmons), 1425
Foreign Bone Marrow in Lethally X-Irradiated Mice Abrogation by Injected Mouse Blood of Protective Effect of (L J Cole and R M Garver), 1815
Foreign Compounds Stimulatory Effect of, on Ascorbic Acid Biosynthesis and on Drug-Metabolizing Enzymes (Dr A H Conney and Dr J J Burns), 363
Foreign Markets British Books and, 605
Foreign Weeds Introduction of, into New Zealand (A J Healy), 1361
Forensic Science Society Meeting at the University of Nottingham to discuss the formation of a, 508
  Formation of the, 1271
Forest of Dean Committee Report for 1958 (Forestry Commission), 1005
Forest Areas Effects of, on Water Resources, and the Technique of Lysimeters—Water and Woodlands (Dr L Leyton), 1184 , Lysimeters (F W Green), 1186
Forest-Tree Litter Extracts Factors in, affecting the Growth of Soil Micro-organisms (Dr Roger Knowles and Edward Laishley), 1169
Forest (Rain-) Zone Non-Symbiotic Nitrogen Fixation in a Soil of the Nigerian (Dr A W Moore and J N Abaelu), 75
Forestry in New Zealand (Sir Harry Champion), 606
Forestry Commission Report of the Forest of Dean Committee (1958), 1005
  Thirty-ninth Annual Report (1957-58), 1457
Fork, D C (Haxo, Dr F T , and) Photoreactive Pigments in Flagellates—Photosynthetically Active Accessory Pigments of Cryptomonads, 1051
Form of Soluble Derivatives Extraction of the Total Protein from Wheaten Flour in the (E E McDermott and Dr J Pace), 546
Form (Upper) Science by the (British Association for the Advancement of Science, Section X (Assembly of Corresponding Societies), Meeting on), 596
Form Reversal in Aphids Ants and (Dr Bruce Johnson), 740
Formalin Estimating Earthworm Populations by using (Dr F Raw), 1661
Formalization of Constructive Concepts, *review* by Dr Hao Wang, 1435
Formation of Allantoin and Allantoic Acid from Adenine in Leaves of *Acer saccharinum* L (Robert L Barnes), 1944
Formation of Different Cell–Virus Relationships in Tumour Cells induced by Polyoma (Dr Leo Sachs and Ernest Winocour), 1702
Formation of Enzyme-Substrate Complex Proof of the, by 'Crossing-Paper Electrophoresis' (Prof S Nakamura, K Takeo, I Sasaki and M Murata), 638
Formation of 3-Hydroxytetrahydrothiophene-1,1-dioxide *in vivo*, and Reactions with Thiols *in vitro* Metabolic and Chemical Studies of 'Myleran'— (Dr J J Roberts and Dr G P Warwick), 1288
Formation of Leucrose in Dextran-producing Cultures of *Streptococcus bovis* (R W Bailey and Prof E J Bourne), 904
Formation of Long Platelets from Pulmonary Megakaryocytes A Possible Explanation of the (Dr J George Sharnoff), B A 75
Formation of Noradrenaline from Adrenaline by Rat Liver Mitochondria (Dr Kunio Yagi and Dr Toshiharu Nagatsu), 1316
Formation of Polygalacturonase in Lucerne and Clover Effect of *Rhizobium* Polysaccharide on the (H Ljunggren and G Fahraeus), 1578
Formation of Polyols by the Lens of the Rat with 'Sugar' Cataract (Dr Ruth van Heyningen), 194
Formation of the Porphyrin Ring (Prof Jonathan B Wittenberg), 876
Formation of Stellar Associations from Galactic Gas (Prof Vladimir Vand), 441
Formation of Streptolysin S by Streptoccal Protoplasts (Dr Yoshiharu Maruyama, Sadako Sugai and Prof Fugio Egami), 832
Formation of the Toxoid of Histamine Sensitizing Factor in *Bordetella pertussis* (Prof Toshitaka Matsui and Yoshio Kuwajima), 199
Formation of the Virus of Foot-and-Mouth Disease Effect of Proflavine on the, and its Infective Ribonucleic Acid in Pig Kidney Tissue Culture Monolayers (Fr Brown and Doreen L Stewart), B A 74
Formation (Antheridium), in the Fern Species *Anemia phyllitides* Control of (Dr Ulrich Näf), 798
Formation (Antibody) Specific Inhibition of, during Immunological Paralysis and Unresponsiveness (Dr E Sercarz and Dr A H Coons) 1080
Formation (Cell-Wall), in Root Hairs (A B Wardrop), 996
Formation (Complex), of Chlorpromazine with Flavins (Dr Kunio Yagi, Takayuki Ozawa and Toshiharu Nagatsu), 982
Formation (Concept-), and Language Classification, (British Society for the Philosophy of Science Symposium on), 1193
Formation (Deoxyribonucleic), in Multiplying HeLa Cells (C L Smith, A A Newton and P Wildy), 107
Formation (Lesion), in Virus-infected Plant Tissues Biochemical Mechanism of (Dr F Solymosy, Dr G L Farkas and Dr Z Kiraly), 706
Formation (Phage) Induction of, in the Lysogenic *Escherichia coli K*-12 by Mitomycin C (Dr Nozomu Otsuji, Dr Mutsuo Sekiguchi, Dr Teiji Iijima and Dr Yasuyuki Takagi), 1079
Formation (Sclereid), in the Leaf of *Camellia japonica* Pattern and Control of (Donald E Foard), 1663
Formation (Skeletal), in the Chick Embryo Inhibition of, following Administration of Tetracycline (Gerrit Bevelander, Hiroshi Nakahara and Gloria K Rolle), 728
Formation (Spore), in *Bacillus licheniformis* Antibiotic Production as a Function of (Robert W Bernlohr and G D Novelli), 1256
Formation (Unexpected), of Volatile Compounds on Gas–Liquid Chromatography Columns (C Weurman and J Dhont), 1480
Formats (Printing Types and) Effects of, on the Comprehension of Scientific Journals (E C Poulton), 1824
Formic Acid (Anhydrous) Action of, on Peptides and Proteins (H Kienhuis, G Blasse and J Matze), 2015
Forms (Diverse Morphological), in *Convolvulus pluricaulis* Chois Intraspecific Polyploidy and Evolution of (Dr S L Tandon and C P Mzalik), 481
Forms (Spiral and other Growth), of Synthetic Diamonds—a Distinction between Natural and Synthetic Diamond (Prof S Tolansky and Dr I Sunagawa), 1526
Formulations (Soil Insecticide and Nematicide) Effect of Emulsifiers and Organic Diluents in (F T Phillips), 1512
Formyl Porphyrins Reaction of, with Acetone-Hydrochloric Acid (Dr P S Clezy), 1142
Forrest, J A (Conway, Dr Elsie, and) Effects of Substituted Phenoxy-Compounds and other Translocated Herbicides on the Rhizome of Bracken, 1416
Forssberg, A Biological Effects of Low Doses of Ionizing Radiations (Types of Immediate Response to Irradiation), 1112
Forster, Prof Th Transfer Mechanisms of Electronic Excitation (Spiers Memorial Lecture of the Faraday Society), 688
  Fast Chemical Reactions in Solution (Transfer of Electronic Excitation Energy between Molecules), 1454
Forsterite Measurement of Intergranular Diffusion in a Silicate System—Iron in (Prof John J Naughton and Yasuo Fujikawa), B A 54
Forsythe, George E , and Rosenbloom, Paul C Numerical Analysis and Partial Differential Equations, *review* by Prof T A A Broadbent, 576
Fortet, Robert, and others Some Aspects of Analysis and Probability, *review* by D G Kendall, 214
Fossil Calcareous Organisms Determination of the Temperatures of Ancient Seas by the Measurement of the Oxygen Isotopes Ratio in (Y A Birstein), 1025
Fossil Cephalopoda Conchiolin Remnants in Mother-of-Pearl from (Dr Ch Gregoire) 1157
Fossil Meteorite ? (A I Shulzhenko) 1026
Fossil Penguin (New), from Australia (G G Simpson), 1612
Fossil Pollen from Seymour Island, Antarctica (Lucy M Cranwell), 1782
Fossil Skull (A New), from Olduvai (Dr L S B Leakey), 491
Foster, Dr A B , and others Biological Origin and Configuration of 10-Hydroxy-Δ^2-decenoic Acid, 634
  Action of Manganese Dioxide on Simple Carbohydrates, 1301
Foster, A S Origin and Dispersal of Flowering Plants (Certain Herbaceous Ranalean Forms might represent an early Angiospermous Type with Dichotomous Venation), 1200
Foster, A S , and Gifford, Jr , Ernest M Comparative Morphology of Vascular Plants, *review* by Dr S Williams, 84
Foster, J W (Leadbetter, E R , and) Incorporation of Molecular Oxygen in Bacterial Cells utilizing Hydrocarbons for Growth, 1428
Foster, K Awarded the Heinrich Hertz Premium of the British Institution of Radio Engineers 857
Fotino, M , and others Loss of Plasticity of Erythrocytes coated with Incomplete Antibodies, 1808
Foulkes, Paul (edited by) Wisdom of the West (Bertrand Russell), *review* by Gerd Buchdahl, 1829
Foundations of Set Theory (Prof Abraham A Fraenkel and Prof Yehoshua Bar-Hillel), *review* by Dr L S Goddard, 1178
Foundations (Conceptual), of Science, *review* by Gerd Buchdahl, 572
Fourier Series, *review* by Prof T A A Broadbent, 1176
Fowden, Dr L (Noe, Dr F F , and) α-Amino-β-(pyrazolyl-N) Propionic Acid a New Amino-Acid from *Citrullus vulgaris* (Water Melon), B A 69
Fowl Semi-Albino, a Third Sex-linked Allelomorph of Silver and Gold in the (W F Werret, A J Candy J O L King and Dr P M Sheppard), 480
Fowles, Dr G W A Title of senior lecturer in chemistry at the University of Southampton conferred on, 595
Fox, P G Supercooling of Water Droplets, 546
Foxon, Prof G E H Visual Illustration of University Lectures, 515
Fraction (Paraffin Wax), from Tobacco Leaf and Tobacco Smoke Composition of a (Dr W Carruthers and Dr R A W Johnstone), 1131
Fraction (Phosphatido-Peptide), of Pancreas Slices Effect of Acetylcholine on the Incorporation of Radiophosphorus into the (Prof C G Huggins), 1412
Fraction (Unsaponifiable), of Crude Vegetable Oils Chromatographic Identification of the Antilipaemic X Factor of the (Prof M C Nath, A Saikia and B I Uppin), 1635
Fractional Micro-sublimation Technique (W H Melhuish), 1933
Fractionation of the System bringing about Oxidative Phosphorylation in *Azotobacter vinelandii* (H G Hovenkamp), 471
Fractionation Phenomena in Nuclear Weapons Debris (K Edvarson, Kerstin Low and J Sisefsky), 1771
Fractionation (Chromatographic), of Rat Tail Tendon Collagen (Alexander Kessler, Hyman Rosen and Dr Stanley M Levenson), 1640
Fractionation (Dose) An Effect of, on the Incidence of Bone Tumours using Radioactive Phosphorus (Dr N M Blackett), 565
Fractionation (Routine) The Behaviour of Haptoglobin during (Marion Steinbach and L Pejaudier), 362
Fractions (Biologically Active), of Deoxyribonucleic Acid Immunization with and Subsequent Specific Infection of Mice (Dr M Kohoutova), 1965
Fractions (Promethium Plasma), in Rats Distribution of (Dr Bergene Kawin), 1722
Fractions (Subcellular) Distribution of Enzyme Systems responsible for Steroid Metabolism in Different Tissues and (Virendra B Mahesh and Frank Ulrich), 1147
Fracture Atomic Mechanisms of (United States National Academy of Sciences—National Research Council Conference on), 324
Fracture (Chain), and Cross-Linking of Rubber by High-Energy Radiation Estimation of (P Hayden), 1865
Fractures (Bone) Urinary β-Glucuronidase Activity in Patients with (F J W Lewis and Dr Constance H J Plaice), 1249
Fraenkel, Prof Abraham A , and Bar-Hillel, Prof Yehoshua Foundations of Set Theory, *review* by Dr L S Goddard, 1178
Fraenkel, Prof G (Yamamoto, Dr Robert T , and) Common Attractant for the Tobacco Hornworm, *Protoparce sexta* (Johan) and the Colorado Potato Beetle, *Leptinotarsa decemlineata* (Say), 206
Fraenkel-Conrat, H Specificity in Protein Biogenesis (Structure of Tobacco Mosaic Virus), 1198
Fragments (Cell) Paper Chromatography of (A T Wilson), 2016
Français, G (Barrere, M , and) Chemistry of Propellants (Air-Burning Fuels—Properties and Preparation of Ramjet Fuels), 779
France, W G (Bingold, A C , and) Biomechanics (Film on Late Results of Four Massive Internal Prosthesis), 513
France Faune de, Vol 62, Coléoptères Curculionides troisieme partie (Adolphe Hoffmann), *review* by R T Thompson, 573
  The Weevils of, *review* by R T Thompson, 573
Francis, Frank C Elected an Honorary Member of the American Academy of Arts and Sciences, 409

Francis, G Ionization Phenomena in Gases (Recent Identification of Alfven Waves in a High-Current Toroidal Discharge), 1356
Francis, Dr G H, and Charig, Dr A J Return from the British Museum (Natural History) Expedition to South Peru, 1687
Francis, Dr W W *Obituary* by Dr W R Bett, 316
Frani, Prof F C, and others Evidence for Distinct Sectors in Polymer Single Crystals, 810
Frank, Louis A (Van Allen, Prof James A, and) Radiation Measurements to 658,000 km with *Pioneer IV*, 219
Frankel, Fred R, and others Mechanism of Immunological Unresponsiveness, 873
Frankenburg, W G, and others (edited by) Advances in Catalysis and related Subjects, Vol 10, *review* by Dr F S Stone, 1974
Franklin, C A, and others Measurement of Cosmic Noise at Low Frequencies above the Ionosphere, 785
Franklin, Dr Richard M, and Wecker, Dr Eberhard Inactivation of some Animal Viruses by Hydroxylamine and the Structure of Ribonucleic Acid, 343
Franklin Institute John Price Wetherill Medals awarded to Dr A J P Martin, Dr R L M Synge and Dr A T James, 857
  Annual Report for 1958, 1279
Frans, Jobsis (Chance, Prof Britton, and) Changes in Fluorescence in a Frog Sartorius Muscle following a Twitch, 195
Fraser, Prof D A S Statistics, an Introduction, *review* by J Durbin, 1008
Fraser, Dr G P (Shivas, Dr A A, and) Lymphoid Necrosis Induced by Lipid Emulsions, 1813
Fraser, Dr J H Atlantic Hydromedusae, *review*, 300
  Polar Front Survey (Biology—Indicator Species in the Faroe–Iceland Ride Region), 1183
Fraser, R D B Structure and Chemistry of Proteins (Structural Organization of Keratin), 1276
Frater, R, and others Structure and Chemistry of Proteins (Rôle of Thiols in Disulphide Interchange Reactions), 1277
Frazer, Dr J F D British Mammals and some Others, 29
Fredericks, E M, and others Carrier Gas and Sensitivity in Gas Chromatography, B A 54
Free, Dr John B, and Butler, Dr Colin G Bumblebees, *review* by Dr M Delia Allen, 1178
Free Energy of Hydrolysis of Adenosine Triphosphate Equilibrium Constant of the Galactokinase Reaction and (Dr M R Atkinson, Eleanor Johnson and Prof R K Morton), 1925
Free-Floating Marine Red Alga (Dr H B S Womersley and Dr R E Norris), 828
Free Learning A Defence of (Lord Beveridge), *review* by R Brightman, 576
Free Radicals, an Introduction (A F Trotman-Dickenson), *review* by Dr T M Sugden, 1259
Free Radicals in Coal during Carbonization at Different Heating Rates Number of (J Smidt and Prof D W van Krevelen), 719
Free Radicals as Studied by Electron Spin Resonance (Dr D J E Ingram), *review* by Dr T M Sugden, 1259
Free Radicals in X-Rayed Seeds of High and Low Water Content, as Measured by Electron Spin Resonance (Dr W Klingmuller, Dr G R Lane, M C Saxena and Dr D J E Ingram), 464
Free Sulphydryl (Cystine-Cysteine, Glutathione and Total) Contents of, in Arsenic-resistant and Sensitive Strains of the Blue Tick, *Boophilus decoloratus* (Dr J S Harington), 1739
Free Trade in Land in the Victorian Period (O R McGregor), 1916
Freed, Prof V Plant Growth Regulation (Physical Chemical Aspects of Synthetic Auxins with respect to their Mode of Action), 600
Freeman, D E, and Ross, Dr I G At the Second Australian Spectroscopy Conference (Results of a Normal Co-ordinate Analysis of the 33 Planar Vibrations of Naphthalene), 1196
Freeman, Dr H C, and others Crystallographic Studies of the Biuret Reaction, 707
Freeman, Dr Thomas, and others Chronic Schizophrenia, *review* by Prof Martin Roth, 487
Freeze-dried Pork and Fish Absorption of Atmospheric Moisture by (Norman A Matheson), 1949
Freezing at an Extremely Low Temperature Prefreezing as a Method enabling Animals to survive (Eizo Asahina), 1003
French Blood Donors Frequencies of the Haptoblobin Groups in 406 (Dr J Moullec and Dr J M Fine), 196
French Journal of Science Teaching, 593
Frequencies of the Haptoglobin Groups in 406 French Blood Donors (Dr J Moullec and Dr J M Fine), 196
Frequencies (Low) Measurement of Cosmic Noise at, above the Ionosphere (J P I Tyas, C A Franklin and A R Molozzi), 785
Frequency of Caesium in Terms of U T $+\Delta T$ An Error in the Determination of ΔT from the Lunar Ephemeris and the (C A Murray), 441
Frequency of the New Blood Group Antigens Js^a among South American Indians (Dr Miguel Layrisse and Dr Zulay de Layrisse), 640
Frequency (Caesium), and Time Standard An Improved (Dr L Essen and J V L Parry), 1791
Frequency (Fusion), and Light Quantity (A Angel, D A Hems, W Rose, R C Woledge and Dr R A Weale), 1873
Frequency (Low-) (100 kc/s) Radio Noise from the Aurora (R L Dowden), 803
Frequency (Very High) Radio Signals at Ionospheric Heights Refraction of (S Weisbrod and L Colin), 119
Frequency (Very Low) Phenomena at Godhavn, Greenland Observations of 'Whistlers' and (Eigil Ungstrup), 806
Frequency (Very Low-) Spectra of Atmospherics propagated through the Ionosphere (Tatsuzo Obayashi), 34
Frequency Lines Auroral (Dr J M Stagg), 262, (Dr Bengt Hultqvist), 263
Frequency Range (Encephalographic) Subjective Light Pattern Spectroscopy in the (Prof M Knoll and J Kugler), 1823
Fresh Nerve Cells (Isolated), and Glial Cells from Control and Stimulated Animals Quantitative Assay of Compounds in (Prof Holger Hyden), 433
Freshwater Biological Association Twenty-seventh Annual Report (1958-59), 1845
Freshwater Phytoplankton Buoyancy in relation to the Ecology of the (Dr J W G Lund), 1534
Freud, Anna Elected an Honorary Member of the American Academy of Arts and Sciences, 409
Freundlich, Prof E F Retirement from the directorship of the University of St Andrews Observatory, 768, work of, 768
Frey-Wyssling, Prof A, and Buttrose, Dr M S Photosynthesis in the Ear of Barley, 2031
Frick, Dr M H, and others Release of Adenosine Triphosphate and Serotonin from Injured Cellular Blood Elements in Extracorporeal Circuits, 1127
Fricke (Sophie) Research Fellowship in the Rockefeller Institute awarded to Dr J S Gillespie, 595
Friction in Textiles (Dr H G Howell, K W Mieszkis and Dr D Tabor), *review*, 1765
Friction Coefficients (Rotational), of Models of Tobacco Mosaic Virus and the Size of the Virus Particle (Dr A J Haltner and Dr B H Zimm), 265
Fridrichsons, J, and Mathieson, A McL Structure and Chemistry of Proteins (Three-dimensional Structure of Toluene-*p*-sulphonyl-L-prolyl-L-hydroxyproline Monohydrate), 1276
Fried, Jojtech, and others Vapour–Liquid Equilibrium (translated by G Standart), *review* by Dr R Sargent, 837
Friend, J, and Nakayama, T O M Destruction of Carotenoids in Isolated Chloroplasts, B A 66
Friend, Dr J A, and Lyons, Dr L E At the Second Australian Spectroscopy Conference (Two Transitions in the Crystal Spectrum of Sodium Nitrate), 1196
Friends of the Lake District Annual Report, 1844
Fries, Dr Bengt Effect of Polyphloretin Phosphate on the Suspension Stability of Red Blood Corpuscles, 62
Fripiat, Prof J J Clay Minerals (Surface Structure in Clays), 780
Frog Hypophysial Extracts (Fish and) Chromatographic and Biological Characteristics of (Active Principles of the Neurohypophysis of Cold-blooded Vertebrates), (B T Pickering and Prof H Heller), 1463
Frog Nerve Cells Resting and Action Potentials of Reversed Polarity in (Dr I Tasaki), 1574
Frog Sartorius Muscle Changes in Fluorescence in a, following a Twitch (Prof Britton Chance and Frans Jobsis), 195
Frohlich, Prof H Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 157
Frommhold, L Ionization Phenomena in Gases (Measurement of the Drift Velocity and Mean Energy of Agitation of Electrons), 1354
Frondel, Prof Clifford Systematic Mineralogy of Uranium and Thorium, *review* by Prof C F Davidson, 576
Front (The Moving), of Carbohydrates, *review* by Dr Alfred Gottschalk, 662
Frontali, Laura, and Tecce, Giorgio Enzymic Conversion of L-Rhamnulose to L-Fuculose in *Escherichia coli*, 1315
Froome, Dr K D A New Microwave Harmonic Generator, 808
Froyd, G, and Round, M C Infection of Cattle with *Cysticercus bovis* by the Injection of Onchospheres, 1510
Frozen Fat Body Cells in an Insect Survival of (R W Salt), 1426
Fructifications (Presumed Glossopteridean) Occurrence of, in Rhodesia and Nyasaland (Dr William S Lacey), 1592
Fruit Production Tree (Dr James S Shoemaker and Dr Benjamin J E Teskey), *review* by Prof H W Miles, 487
Fruit Set in Sweet Potato Effect of Indole Acetic Acid and α-Naphthalene Acetic Acid on the Growth, Flowering and (G Satyanarayana and Dr G Rangaswami), B A 73
Fruitlets (Apple) A Kinin in (Dr P L Goldacre and Dr W Bottomley), 555
Fry, Dr R J M (Acheson, Fiona, and) Induced Tolerance to D-Tubocurarine Chloride in the Cat, 1409
Fry, W L Origin and Dispersal of Flowering Plants (Angiosperms in various Tertiary Floras of Canada), 1201
Frye, William Antibiotics in Tropical Disease, 1115
Fuchs, Sir Vivian Research in the Antarctic during 1960, 851
Fuchsia Female-sterile Flowers in (M Holdsworth), 1024
L-Fuculose Enzymic Conversion of L-Rhamnulose to, in *Escherichia coli* (Laura Frontali and Giorgio Tecce), 1315
Fuel Uranium as, 318
Fuel Treatment Nuclear, *review* by Dr J E Littlechild, 1346
Fuels (Nuclear) Chemical Processing of (Dr F S Martin and Dr G L Miles), *review* by Dr J E Littlechild, 1346
Fueter, Dr Ed At the 139th Annual Meeting of the Swiss Society for Natural Sciences (On the little-known Mathematician and Philosopher de Crousaz, of Lausanne, 1663-1750), 1455
Fuhrman, Frederick A, and Giese, Arthur C (edited by Victor E Hall, in association with) Annual Review of Physiology, Vol 21, *review* by Prof. D C Harrison, 838
Fujikawa, Yasuo (Naughton, Prof John J, and) Measurement of Intergranular Diffusion in a Silicate System—Iron in Forsterite, B A 54
Fujimoto, M Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Fujino, Prof Yasuhiko, and Negishi, Takashi Presence of Behenic Acid in Sphingomyelin from Horse Spinal Cord, 817
Fujita, Toshio, and others Plant Growth Activities of 5- and 8-Halogeno-Dihydro- and Tetrahydro-1-naphthoic Acids, 1415
Fukai, R, and Meinke, Prof W W Some Activation Analyses of Six Trace Elements in Marine Biological Ashes, 815
Fukasawa, Toshio, and Nikaido, Hiroshi Galactose-sensitive Mutants of *Salmonella*, 1168
Fulbright Programme Travel Grants, 1273
Fuller, Dr R C (Bergeron, Dr J A, and) Influence of Carotenoids on the Infra-Red Spectrum of Bacteriochlorophyll in *Chromatium*, 1340
Fulton, Dr Forrest Title of professor of virology in the University of London (at the London School of Hygiene and Tropical Medicine) conferred on, 1108
Fulton, Dr J D *Obituary* of Dr Louise Pearce, 588
  Chagas's Disease, 1114
Funck, Major Bertil Oil Pollution of the Sea (Recurring Pollution of the Baltic), 950
Function of Carotenoid Pigments in Non-Photosynthetic Bacteria (Micheline M Mathews and W R Sistrom), 1892
Function of Carotenoids in Photosynthetic Bacteria (Prof M Dworkin), 1891

Function for the Extracellular Polysaccharide of *Azotobacter vinelandii* (Dr Michael H Proctor), 1934
Function of Spore Formation in *Bacillus licheniformis* Antibiotic Production as a (Robert W Bernlohr and G D Novelli), 1256
Function (Colloid-storing), of Histiocytes A Method for *in vitro* Investigation of the (Prof N Jancso, Aurelia Jancso-Gâbor and J Balassy), 1070
Function (Confusion) A Mathematical Model for Perception and a Theoretical (M Hammerton), 1668
Function (Enhanced Synaptic), due to Excess Use (Dr Rosamond M Eccles and Dr R A Westerman), 460
Functional Analysis Introduction to (Prof Angus E Taylor), *review* by Prof T A A Broadbent, 666
Functional Groups (Oxygen-containing), in the Organic Matter of a Podzol Soil (J R Wright and M Schnitzer), 1462
Functional Interpretation of the Electron-Microscopic Structure of the Sensory Hairs in the Cristae of the Elasmobranch *Raja clavata* in Terms of Directional Sensitivity (Prof O Lowenstein and J Wersäll), 1807
Functional Lateral Nasal Gland (Salt Gland) Captive Marine Birds possessing a (Prof Larry Z McFarland), 2030
Functional Organization of the Respiratory Chain in Liver Mitochondria (Dr Tokuji Kimura and Dr Thomas P Singer), 791
Functioning of the Lungs A New Method for Studying the (Helge Colldahl, T Alvager and J Uhler), 372
Fundamental Cancer Research Fourteenth Annual Symposium on (Cell Physiology of Neoplasia), (University of Texas Anderson Hospital and Tumour Institute), 1451
Fundamental Research in Britain, 1
Fundamentals of Gas Dynamics (edited by Howard W Emmons), *review* by Prof J H Horlock, 1173
Fundamentals of Papermaking Fibres—Transactions of the Symposium held at Cambridge, 1957 (edited by Francis Bolam), *review* by Dr Julius Grant, 1011
Fundamentals of Statistical Reasoning (M H Quenouille), *review* by Dr D J Finney, 217
Funds for Research and Development Performance in American Industry (United States National Science Foundation, Reviews of Data on Research Development No 14), 1022
Fungal Arbuscular Organs Production of, on Laboratory Media (G A Atkins), 1738
Fungal Physiology A Source Book of, *review* by Dr J L Harley, 85
Fungal Spore Morphology '*LO*-Analysis' as an Aid in the Study of (Dr M M Payak), 738
Fungi British Parasitic (W C Moore), *review* by Dr Lilian E Hawker, 1977
    Physiology of (Prof Vincent W Cochrane), *review* by Dr J L Harley, 85
Fungi in Agar and Soil Cultures Translocation of Cobalt-60 and Caesium-137 by (Dr Erna Grossbard and Dr D R Stranks), 310
Fungi (Pathogenic and Non-Pathogenic) Human Precipitins against Common (Dr J Pepys, Dr R W Riddell and Dr Y M Clayton), 1328
Fungi (Soil), in the Belgian Congo, 236
Fungi (Water), *Blastocladiella* and *Allomyces* *Gamma* Particles, Nadi-Positive Mitochondria, and Development in the (Prof Edward C Cantino and Gilbert Turian), 1889
Fungistatic Antibiotics Inhibitory Effect of, on the Production of Amylase by *Penicillium chrysogenum* (Dr I Horvath and A Szentirmai), 57
Fungitoxicity of Metal Ions (Dr E Somers), 475
Furka, A (Szell, Dr T, and) A New Method for Working up Processing Mixtures containing Anhydrous Aluminium Chloride, 117, *erratum*, 595
Furnaces for Glass Melting The Development of (Dr W M Hampton), 772
Furon, Raymond Causes de la Répartition des Etres Vivants, *review* by Prof Ronald Good, 390
Furst, Arthur, and others Phenazine Di-*N*-Oxide as a Carcinostatic Agent, 908
Furst, Dr M, and others Energy Transfer with special reference to Biological Systems (Electronic Energy Transfer in Solution), 689
Furth, Dr H P Thermonuclear Processes (Hydrodynamic Stability Studies using Plasma and Magnetic Field Configurations), 241
    Ionization Phenomena in Gases (Linear and Toroidal Hard-core or Inverse Pinch), 1357
Furth, Dr R Fluctuation Phenomena and Stochastic Processes (Fluctuations of Macroscopic Parameters), 509
Further Education, Yorkshire Council for, and others Symposium on Recent Developments in Textile Chemistry, 1845
Furukawa, Dr Kazuo A Structural Model for Monatomic Liquids including Metallic Liquids, 1209
Furusaka, Choseki (Hattori, Tsutomu, and) Chemical Activities of *E coli* adsorbed on a Resin, 'Dowex-I', 1566
Fusarium Production of Emetic Material by Species of (Neville Prentice, A D Dickson and Prof J G Dickson), 1319
Fusarium oxysporum f *cubense* A Rapid and Simple Pathogenicity Test for Detecting Virulent Clones of, using Seedlings of *Musa balbisiana* (Dr R H Stover), 1591
Fusarium oxysporum (Pathogenic) Production of a Perfect Stage in a Nutritionally Deficient Mutant of, after Ultra-violet Irradiation (E W Buxton), 1258
Fused and Crystalline Silica Structural Defects in (Dr W C Levengood), 1476
Fusion Frequency and Light Quantity (A Angel, D A Hems, W Rouse, R C Woledge and Dr R A Weale), 1873
Fussell, G E British Agricultural History Society—Winter Conference, 1916
Future of Broadcasting and Television, 1747
Future of Chemicals from Petroleum (L H Williams), 1915
Future of the Etruscans, *review* by Madeleine Smith, 1348

GABRIEL, A H Thermonuclear Research, 1016
Gage, Dr M Appointed Research Fellow in geology in the University of Birmingham, 1915
Gagliardi, Dr Leola A, and others An Experimental Enterococcal Pyelonephritis in Mice, 561
Gain in Body-Weight by Turkey Poults Effect of Thioctic Acid on (J R Jowsey, R M Blakeley and H I MacGregor), 1323
Gaines, jun, George L Concentration of Stearic Acid in Monolayers Adsorbed from Solution, 1139
Galactic Gas Formation of Stellar Associations from (Prof Vladimir Vand), 441
Galactokinase Reaction Equilibrium Constant of the, and Free Energy of Hydrolysis of Adenosine Triphosphate (Dr M R Atkinson, Eleanor Johnson and Prof R K Morton), 1925
Galactose Cataract (Experimental) Carbohydrate Metabolism in the (Dr Sidney Lerman), 1406
Galactose-sensitive Mutants of *Salmonella* (Toshio Fukasawa and Hiroshi Nikaido), 1168
Galer, C S At the first Conference of the British Computer Society (Use of Computers for Operations Research), 946
Gallagher, Dr C H (Koch, Dr J H, and) Effect of some Neuromuscular Blocking Agents on Mitochondrial Enzyme Systems, 1039
Gallagher, Dr C H, and Simmonds, R A Prophylaxis of Poisoning by Carbon Tetrachloride, 1407
Gallic Acid in *Phycomyces* Sporangiophores (David S Dennison), 2036
Garlick, J P, and others Haptoglobin and Transferrin Variants in Bushmen and some other South African Peoples, 2042
Gallinaceous Birds Immunological Distances among some (Danile Mainardi), 913
Galus, Zbigniew, and others Influence of Gold in a Mercury Electrode on certain Electrode Processes, B A 56
    Influence of Platinum in Mercury on the Mechanism of Electrode Reactions at the Mercury Electrode, 1795
Games Mathematical, 770
γ-Aminobutyric Acid Quantitative Changes in, induced by Low Temperature in Rice Plants (F Zsoldos), 280
γ-Aminobutyric Acid Content of Rat Brain Increase in the, after Ingestion of Ethanol (Dr H -M Hakkinen and E Kulonen), 726
γ-Benzene Hexachloride and Dieldrin Resistance of Houseflies to (R G Bridges and J T Cox), 1740
γ-BHC and Dieldrin Resistance of Houseflies to (R G Bridges and J T Cox), 1740
γ-Globulin (Human) Staphylocoagulase Inhibition by Pooled (Prof Murray M Streitfeld, Prof Bennett Sallman and Seymour M Shoelson), 1665
γ-Globulin (Rabbit) *Iso*-Antigens of (S Dubiski, Danuta Skalbz, Anna Dubiska and Dr A Kelus), 1811
γ-Globulins (Fast-Moving) Separation of, by Starch-Gel Electrophoresis (Dr M D Poulik, Dr W W Zuelzer and Dr R Meyer), 1800
γ-Irradiated Potato Starch Granules Physical and Chromatographical Observations of (Akira Mishina and Ziro Nikuni), 1867
γ-Irradiation Separation by, of Two Elements at the Vby Locus in *Trifolium repens* (Dr D Roy Davies and E T Wall), 1957
γ-Irradiation (Whole-Body) Cells which Synthesize Deoxyribonucleic Acid in Guinea Pig Bone Marrow during Recovery from (P F Harris and J H Kugler), 1883
γ-Radiation Effect of, on the Synthesis of Methanol over Zinc Oxide (T I Barry and R Roberts), 1061
γ-Radiation from Deposited Fall-Out (D H Peirson and L Salmon), 1678
γ-Radiation (Background), in Leeds during 1955-59 Some Measurements of (Prof F W Spiers), 1680
γ-Rays A Capacitance Method for following Vinyl Polymerizations initiated by (G J K Acres and F L Dalton), 335
γ- and α-Globulins Production of, by the Isolated and Perfused Rat Spleen (Dr E Espinosa), 1801
Gamma Particles, Nadi-Positive Mitochondria, and Development in the Water Fungi, *Blastocladiella* and *Allomyces* (Prof Edward C Cantino and Gilbert Turian), 1889
Gammel, Dr J L Nuclear Forces and the Few-Nucleon Problem (Binding Energies and Elastic Scattering of Light Nuclei at Low Energies—Attempts to Integrate the *n–d* Problem Numerically), 1114
Gamow, Prof George Matter, Earth and Sky, *review* by G R Noakes, 214
Gamow, Prof George, and Stern, Dr Marvin Puzzle-Math, *review* by Prof T A A Broadbent, 217
Ganglion-blocking Activity (High) Congeners of Pempidine with (L Bretherick, G E Lee, E Lunt, W R Wragg and N D Edge), 1707
Ganglion Blocking Drugs Action of, on Choline Acetylase (Dr J E Gardiner), B A 71
Ganguly, A J Awarded an Overseas Scholarship by the Royal Commission for the Exhibition of 1851, 409
Garamba, Exploration du Parc National de la Mission H de Saeger, Fasc 9, Ecologie et Biologie des Grands Mammifères (Primates, Carnivores, Ongulés), (Jacques Verschuren), 155
Garcia, J, and others A Lesion of the Follicle and of the Fibre of Wool and its Possible Relation with an Excess of Iron in the Forage, 559
Gard, Prof Sven The Structure of Science, B A 9
Gard, Prof Sven, and others Statement on Biological and Chemical Warfare, 1018
Garden Insects in the (Educational Productions, Ltd, Filmstrip No 5260), 1777
Gardiner, Dr J E Action of Ganglion Blocking Drugs on Choline Acetylase, B A 71
Gare, L, and others Tocopherols in Micro-organisms, 1339
Garforth, F I de la P Management Development, a Systematic Approach to the Provision of Supervisors and Managers, 319
Garlick, Prof G F J Crystal Physics, 596
Garm, Dr Otto (Austad, Rolv, and) Periodic Acid-Schiff-Positive Material and Alkaline Phosphatase in the Uterine Wall of the Pig during the Sexual Cycle, 999
Garner, R J Distribution of Radioactive Barium in Eye Tissues, 733
Garner, Walter Awarded the Service Medal of the Textile Institute, 156
Garnett, Dr Alice Water-Resources and Water-Use Survey, 96, *erratum*, 684
    Title of reader in geography in the University of Sheffield conferred on, 684
    Economic Developments in the Middle East, 1280
Garren, Henry W (Hill, Charles H, and) Differentiation between a Growth-Promoting Factor and a Tumour-Susceptibility Factor in Eggs, 824

Garrett, Dr K R Gas Chromatography (Report on a Programme of Co-operative Analysis of Hydrocarbon Gases), 328
Gartler, Dr S M Cellular Uptake of Deoxyribonucleic Acid by Human Tissue Culture Cells, 1505
Gartler, Dr S M (Blumberg, Dr B S, and) High Prevalence of High-Level β-Aminoisobutyric Acid Excretors in Micronesians, 1990
Gartside, S (Bloor, J E, and) Effect of Hybridization Changes on the Bond Energies of Carbon–Carbon Single Bonds, 1313
Garver, R M (Cole, L J, and) Abrogation by Injected Mouse Blood of Protective Effect of Foreign Bone Marrow in Lethally X-Irradiated Mice, 1815
Garwood, Dr R F (Hickinbottom, Dr W J, and) Oxidation of Organic Compounds, 326
Gas (Carrier), and Sensitivity in Gas Chromatography (E M Fredericks, M Dimbat and F H Stross), B A 54, (Dr H N Ray), B A 54
Gas (Galactic) Formation of Stellar Associations from (Prof Vladimir Vand), 441
Gas Analyser (The Infra-Red), as a Means of Measuring the Carbon Dioxide Output of Individual Insects (Dr A G Hamilton), 367
Gas Bladder of *Coregonus lavaretus* Rete Mirabile in the (Goran Fahlen), 1001
Gas Chromatographic Columns (Packed and Capillary) Comparison of Efficiency and Separating Power of (Dr J H Purnell), 2009
Gas Chromatographic Separation of Long-chain Fatty Acid Methyl Esters on Polyvinyl Acetate (Irwin Hornstein, L E Elliott and P F Crowe), 1710
Gas Chromatography (Gas Chromatography Discussion Group and the Hydrocarbon Research Group of the Institute of Petroleum Symposium on), 327, 1199
Gas Chromatography Analysis of Permanent Gases by, using a Radioactive Ionization Type Detector (V Willis), 894
  Carrier Gas and Sensitivity in (E M Fredericks, M Dimbat and F H Stross), B A 54, (Dr N H Ray), B A 54
  Progress in (C G Scott), 1199
  Sensitivity of Catharometers in, and the Thermal Conductivity of Binary Gas Mixtures (A B Littlewood), 1631
  Use of Coated Tubing as Columns for (Prof Albert Zlatkis and H R Kaufman), 2010
Gas Chromatography Discussion Group (Hydrocarbon Research Group of the Institute of Petroleum and the) Symposium on Gas Chromatography, 327, 1199
Gas-cooled Reactors Advanced (United States Atomic Energy Commission and the United Kingdom Atomic Energy Authority to exchange Technical Information on), 1361
Gas Dynamics Fundamentals of (edited by Howard W Emmons), *review* by Prof J H Horlock, 1173
  Research in, *review* by Prof J H Horlock, 1173
Gas Engineers, Institution of, and the British Coke Research Association (Coke Oven Managers' Association, the) Joint Meeting, 1778
Gas Hydrates Some Stoicheiometric (Dr D N Glew), 545
Gas Jet (High-Temperature) Blunt-Nosed Bodies in a (F R Sedlund and Prof C C Chang), 812
Gas–Liquid Chromatography Columns Unexpected Formation of Volatile Compounds on (C Weurman and J Dhont), 1480
Gas–Liquid Systems Droplet Circulation and Interfacial Disturbances in (Dr C Ramshaw and Dr J D Thornton), 719
Gas Mixtures (Binary) Sensitivity of Catharometers in Gas Chromatography and the Thermal Conductivity of (A B Littlewood), 1631
Gas Solid Chromatography Separation of the *Meta*- and *Para*-Isomers of the Xylenes, Cresols and Toluidines by (M A Hughes, D White and Prof A L Roberts), 1796
Gases Ionization Phenomena in (J Dutton, D Harcombe and E Jones), 1353
Gases (Permanent) Analysis of, by Gas Chromatography using a Radioactive Ionization Type Detector (V Willis), 894
Gases (Relaxing) Velocity of Sound in (H J Wintle), 2007
Gasification (Carbon) A New Approach to (J D Blackwood and F K McTaggart), 447
Gaskin, A R J Appointed to a lectureship in the Department of Geology in the University of Leeds, 1108
Gasser, Dr Herbert S Honorary degree of D Sc of the Rockefeller Institute conferred on, 26
Gassner, F X (edited by, in association with Rue Jensen and H J Hill) Proceedings of the Third Symposium on Reproduction and Infertility, Colorado State University, *review* by Dr T Mann, 1434
Gasson, D B Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Silicon Crystal Pulling Furnace using Heating by Electron Bombardment), 692
Gastambide-Odier, Dr Mireille, and Lederer, Prof E Biosynthesis of Corynomycolic Acid from Two Molecules of Palmitic Acid, 1563
Gaster (Leon) Memorial Premium for 1959 of the Illuminating Engineering Society awarded to Dr R G Hopkinson and J Longmore, 1272
Gastric Juice (Human) Electrophoresis of (Dr Ragnhild Gullberg and Dr Borje Olhagen), 1848
Gastro-intestinal Tract of the Infant Rat Passage of Insulin through the Wall of the (Dr B Mosinger, Z Placer and O Koldovsky), 1245
Gastropods (Marine) Defensive Acid-Secretion in some (Dr T E Thompson), 1162
Gatehouse, Dr B M, and Walsh, A At the Second Australian Spectroscopy Conference (Direct Analysis of Metals and Alloys), 1197
Gatenby, Prof J Bronte International Cytology, *review*, 574
Gates, Prof R Ruggles Taxonomy and Genetics of *Oenothera*, *review* by Dr W B Turrill, 1974
Gattow, G Thermodynamics (Experimental Thermochemistry), 1607
Gause, G F, and others Rate of Appearance of Mutants with Respiration-deficiency in *Staphylococci*, 1821
Gavin, Prof M R, and Houldin, Dr J E Principles of Electronics, *review* by Prof D G Tucker, 751
Gaydon, Dr A G *Obituary* of Sir Alfred Egerton, 678
Gaydon, Dr A G (Hurle, Dr I R, and) Vibrational Relaxation and Dissociation of Carbon Dioxide behind Shock Waves, 1858
Gaylord, Dr Norman G Appointed editor of *Resins, Rubbers, Plastics*, 1108
Gaz dans les Métaux (Société Française de Métallurgie Journées Métallurgiques d'Automne), 95
Gaze, Dr R (Addingley, Dr C G, and) Measurement of Asbestos Dust Concentrations with the Long-Running Thermal Precipitator, 715
Geake, Dr J E Optics, Classical and Modern, *review*, 130
Gee E P The Great Indian Rhinoceros, 1986
Gel (Agar) Direct Spectroscopic Examination of Electrophoretic Zones in (Dr G H Beaven and W B Gratzer), 359
Gel (Silica) Colour Centres produced by Radiation in (Harold W Kohn), 630, *erratum*, 1026
Gel Filtration as a Method for Purification of Protein-bound Peptides as exemplified by Oxytocin and Vasopressin (E B Lindner, Dr A Elmqvist and Dr J Porath), 1565
Gel (Starch-) Electrophoresis Separation of Fast-Moving γ-Globulins by (Dr M D Poulik, Dr W W Zuelzer and Dr R Meyer), 1800
  Separation of Prealbumins by (Dr M D Poulik), 1067
Gel (Starch-) Electrophoresis of Seminal Plasma, Serum and Bile Visualization of Acid and Alkaline Phosphatase after (Dr Bengt Estborn), 1636
Gel (Starch) Electrophoretic Patterns Localization of Haemocyanin on (J R Whittaker), 193
Gelatine and Glue Research Association (British) Appointment of Dr D A Sutton as director of research, 318
  Seventeenth Meeting of the Research Panel (Alan G Ward), 862
  Discussion on Gelation, 863
Gelation (British Gelatine and Glue Research Association Discussion on), 863
Gell, P G H, and Benacerraf, B Delayed Hypersensitivity, 1030
Gemmology, *review* by Dr W Campbell Smith, 1008
Gemstones (Dr G F Herbert Smith), thirteenth edition revised by Dr F Coles Phillips, *review* by Dr W Campbell Smith, 1008
Gene Mutation Human Haemoglobin *E*—the Chemical Effect of (Abnormal Human Haemoglobins), (Dr J A Hunt and Dr V M Ingram), 870
General Education in a Modern Democracy, 1171
General Electric Company *Atomic Energy Review*, Vol 2, No 1, 407
  The Ophitron, 594
General Electric Company of America Experimental Production of a Transparent Sintered Alumina—'Lucalox', 1107
General Microbiology, Society for Eighth Symposium—The Strategy of Chemotherapy (edited by S T Cowan and E Rowatt), *review* by Prof H Berry, 133
  Ninth Symposium—Virus Growth and Variation (London, 1959), (edited by A Isaacs and B W Lacey), *review* by N W Pirie, 920
General Post Office Appointment of A H Mumford as engineer-in-chief, 1531
  Retirement of Sir Lionel Harris as engineer-in-chief, 1531
  Appointment of Capt C F Booth and D A Barron as deputy engineers-in-chief, 1531
General Register Office Studies on Medical and Population Subjects No 14, Morbidity Statistics from General Practice, Vol I (General), (Dr W P D Logan and A A Cushion), 154
Generation (Power) Nuclear Reactors for (edited by E Openshaw Taylor) *review* by R Vaux, 301
Generator A New Microwave Harmonic (Dr K D Froome), 808
Generators (The Tandem), of the United Kingdom Atomic Energy Authority (K W Allen and F A Julian, W D Allen and A E Pyrah, and J Blears), 303
Genetic Analysis, *review* by J Maynard Smith, 752
Genetic Analysis Trends in (Prof G Pontecorvo), *review* by J Maynard Smith, 752
Genetic Basis of the Thalassaemia Diseases (Prof V M Ingram and A O W Stretton), 1903
Genetic Control of a Cyclic Growth Pattern in *Neurospora* (Growth Patterns in *Neurospora*), (Dr D R Stadler), 170
Genetic Control of Tryptophan Peroxidase-Oxidase in *Drosophila melanogaster* (Corrado Baglioni), 1084
Genetic Interactions (Anomalous), observed in *Bacillus subtilis* (M Kohiyama and Y Ikeda), 208
Genetical Effects of Population Subdivision (P A P Moran), 505
Genetics at Cambridge, 1189
Genetics at Sheffield, 1189
Genetics of Complex Characters Heterosis and the (Watkin Williams), 527
Genetics of *Oenothera* Taxonomy and (Prof R Ruggles Gates), *review* by Dr W B Turrill, 1974
Genetics (Biometrical) Application of, to Behaviour in Rats (Dr P L Broadhurst), 1517
Genetics and the Origin of Species (British Association for the Advancement of Science, Sections D (Zoology) and K (Botany), Symposium on), 587
Gennaro, jun, Prof J F, and Ramsey, H W Distribution in the Mouse of Lethal and Sub-Lethal Doses of Cottonmouth Moccasin Venom labelled with Iodine-131, 1244
Gentisic Acid and *o*-Pyrocatechuic Acid Conversion of Salicylic Acid to, all Labelled with Carbon-14, in Plants (Dr Ragai K Ibrahim and Prof G H N Towers), 1803
Geochemical Research in the United States, *review* by Dr S R Nockolds, 1757
Geochemical Society, Japanese Position and Activities of the (Prof K Sugawara), 1193
Geochemical Work at the Vernadsky Institute, Moscow Current (Prof A P Vinogradov), 1193
Geochemistry Principles of (Prof Brian Mason), second edition, *review* by Dr S R Nockolds, 1601
  Researches in (edited by Philip H Abelson), *review* by Dr S R Nockolds, 1757
Geodesy and Geophysics, National Committee for Appointment of J Connor as chairman, 1192
Geodetic Marker at the South Pole (To be erected by the United States Coast and Geodetic Survey), 1612
Geography and Ecology (Plant), International Society for International Symposium on Mapping Vegetation, B A 23
Geological Congress Inter-University (Eighth), 1914
Geological Development of North America, *review* by Dr J W Cowie, 1600
Geological Documentation Service A New, 153

Geological Museum, London Exhibition of Aerial Photographs of Quarries and Mines, 855
Geological Society (Liverpool) Centenary of the, 1914
Geological Society of London Election of Foreign Members, 1360
Geological Survey (United States) Suggestions to Authors of the Reports of the, fifth edition, *review* by Prof C F Davidson, 390
  Bulletin 1064, Systematic Mineralogy of Uranium and Thorium (Prof Clifford Frondel), *review* by Prof C F Davidson, 576
Geological Time-Scale (Prof J Laurence Kulp, James C Cobb, Leon E Long and Donald S Miller), B A 62 , (Prof C F Davidson), 1310, 1473
Geology A New Introduction to, *review* by Dr J C M Taylor, 1175
  Panbiogeography, or an Introductory Synthesis of Zoogeography, Phytogeography and (Dr Léon Croizat), Vol I, The New World , Vol 2a, The Old World , Vol 2b, The Old World (continuation), *review* by Prof Ronald Good, 924
Geology of the Great Lakes (Prof Jack L Hough), *review* by Prof S E Hollingworth, 665
Geology of Ore Deposits (published in the Russian language by the Academy of Sciences of the U S S R), 410
Geology of Radioactive Raw Materials Mineralogy and (Prof E Wm Heinrich), *review* by Prof C F Davidson, 1262
Geology of Tanganyika Summary of the, Part I, Introduction and Stratigraphy (A M Quennell, A C M McKinlay and W G Aitken), 1688
Geology (Basic), for Science and Engineering (Prof E C Dapples), *review* by Dr J C M Taylor, 1175
Geology (Historical) Outline of (A K Wells), fourth edition, *review*, 1093
Geology (Precambrian), of South-western Australia (A F Wilson , 237
Geology and Multiple Sclerosis (Prof Harry V Warren), 561
Geomagnetic Activity at Halley Bay on Disturbed Days (J MacDowall), 1543
Geomagnetic Disturbrance Correlation between Earth-Current and (V P Hessler and E M Wescott), 627
  Diurnal Variation of Aurora and, at New Zealand Antarctic Stations (Dr T Hatherton and G G Midwinter), 889
Geomagnetic Disturbance and Velocity of Slow-Drift Solar Radio Bursts (M B Wood and C S Warwick), 1471
Geomagnetic Phenomena associated with Nuclear Explosions Some (Dr R G Mason and Dr M J Vitousek), B A 52
Geomagnetic Vertical Intensity around the Magnetic Equator Possible Asymmetry in the Daily Range of the (Dr C A Onwumechilli), 51
Geomagnetic and Ionospheric Phenomena associated with Nuclear Explosions (Dr S Matsushita), B A 33
Geophysical Effects of High-Altitude Nuclear Explosions (W A Feibelman), 442
Geophysical Journal, Vol 2, No I (Royal Astronomical Society), 504
Geophysical Observatory (New), in Belgium, 1022
Geophysical Year, International Annals of the, Vol 6, Manual on Rockets and Satellites (edited by L V Berkner, in association with John Hanessian, Jr , and Leonard Cormier), *review*, 213
  Photography in the (Scientific and Technical Group of the Royal Photographic Society Symposium on), 1032
  Some Achievements (Royal Society), 604
Geophysics, National Committee for Geodesy and Appointment of J Connor as chairman, 1192
George, Prof J C , and Eapen, J Lipase Activity in the Brown and Yellow Adipose Tissue of the Bat, 59
George, K A Plasma Heating by Current-Saturation, 1790
George, II , L A , and Vogt, G S Electron Microscopy of Autoradiographed Radioactive Particles, 1474
Gerard, V B and others Magnetic Effects resulting from Two High-Altitude Nuclear Explosions, B A 34
Gerber, Dr H -J Nuclear Forces and the Few-Nucleon Problem (Binding Energies and Elastic Scattering of Light Nuclei at Low Energies—Polarization Measurements in *n-d* and *p-d* Scattering at Low Energies), 1114
Gerhart, John C , and others Inhibition of Urease by Alloxan and Alloxanic Acid, 1936
Germ-free Vertebrates—Present Status (James A Reyniers and 30 other authors), 1541
Germain, J E , and Valadon, F Coal Science (Chemical Reactions of Coal—Chromatographic Separation of Oxidation Products of Coal), 413
German Plastics Convention Eighth (International Symposium on the Ageing of Plastics), 508
Germinating Uredospores of Wheat Stem Rust, Race 15B Biosynthesis of some Amino-Acids from Sucrose by (B Kasting, A J McGinnis and W C Broadfoot), 1943
Germinating Wheat Isolation and Purification of Nitrate Reductase from Embryos of (D Spencer), 682
Germination Joint Action of Gibberellic Acid and Coumarin in (A M Mayer), 826
  Seed (Educational Productions, Ltd , Filmstrip CX 6290), 1777
Germination of Spores of *Bacillus coagulans* var *thermoacidurans* Rôle of the Glycolytic Enzyme System in the (Prof Mikio Amaha and Tomoko Nakahara), 1255
Germination and Photoperiodic Reaction in the Genus *Chenopodium* (Tourn) L Extreme Sensitivity of (Dr Bruce G Cumming), 1044
Gervy, R , and others A Method of Increasing the Phosphorus Content of Forages, 76
Gessa, G L (Bezzi, G , and) Neuromuscular Blocking Action of some Antibiotics, 905
Gessa, G L , and others Increase by Chlorothiazide of the Paralysing Activity of *d*-Tubocurarine Chloride, 1235
Gettering Material Titanium as a (R L Stow), 542
Getz, G S , and Bartley, W A Cardiolipin-like Compound in Rat Liver Mitochondria, 1229
Gevarkov, - , and others Ionization Phenomena in Gases (The Interaction of a Beam of Charged Particles with a Plasma), 1356
Ghana New Pests of Cocoa (*Theobroma cacao* L) in, following Applications of Insecticides (P F Entwistle, C G Johnson and E Dunn), 2040
Ghizetti, Aldo Awarded a Silver Medal of the City of Paris, B A 16
Ghysdael, P , and others Production of an Agglutinating Auto-Antibody (Panagglutinin) Active upon Tanned Erythrocytes in the Rabbit, 1250
Giant Eggs of the Clover Cyst Nematode, *Heterodera trifolii* Goffart, 1932 (Roland H Mulvey), 1662
Giant Plesiosaur, 1914
Giant Travelling Disturbances and Sporadic E Ionization A Relation between (L H Heisler), 1788
Gibberellic Acid Effect of, on the Initiation of Flowers and Runners in the Strawberry (P A Thompson and C G Guttridge), B A 72
  Effect of the Potassium Salt of, on the Growth and Reproduction Rate of *Paramecium multimicro-nucleatum* (A A Oravec, N G Strovilas, J L Beal and Arthur Tye), 1405
  Effects of, on Juvenility in *Marsilea* and certain other Plants (Dr A Allsopp), 1575
  Effects of Auxin and, on Growth of *Ulothrix* (Dr Herbert Conrad, Dr Paul Saltman and Dr Richard Eppley), 556
  Extended Dormancy of Deciduous Woody Plants treated in Autumn with (Dr P W Brian, J H P Petty and P T Richmond), 69
  Induction of Parthenocarpy in *Rosa arvensis* Huds with (M V Prosser and G A D Jackson), 108
  Influence of Kinetin, β-Indoleacetic Acid and, on Nuclease Activity of Bean (*Phaseolus vulgaris*) Hypocotyls (Dr W Maciejewska-Potapczyk), 557
  Prevention of the Onset of Seed Dormancy by (Dr M Black and J M Naylor), 468, *erratum*, 857
Gibberellic Acid and the Chilling Requirements of Peach Seeds (the late Prof Margaretha G Mes), 2034
Gibberellic Acid and Coumarin Joint Action of, in Germination (A M Mayer), 826
Gibberellic Acid and Nodulation of Legumes (Dr Wm W Fletcher, J W S Alcorn and J C Raymond), 1576
Gibberellic Acid and Photoperiod Influence of, on the Growth, Flowering, Nodulation and Nitrogen Assimilation of *Vicia villosa* (the late Prof Margaretha G Mes), 2035
Gibberellin Effect of, on the Growth of Pollen Tubes (Nanda Bose), 1577
Gibbons, Dr I R An Embedding Resin Miscible with Water for Electron Microscopy, 375
Gibbons, Dr R A Molecular Shape and Physical Properties of Mucin, 610
Gibbons, Dr R A , and Glover, F A Flow Properties of Biological Systems (Measurements of Flow Birefringence), 1540
Gibson, Dr Alan F , and others (edited by) Progress in Semiconductors, Vol 3, *review* by Dr R A Hyman, 1754
Gibson, J B , and Thoday, Prof J M Recombinational Lethals in a Polymorphic Population, 1593
Gibson, Prof Q H Energy Transfer with special reference to Biological Systems (Haemoglobin formed from CO-Haemoglobin), 689
  Fast Chemical Reactions in Solution (Stopped-flow Method to Study the Combination of Haematin and Carboxy-haem with Globin), 1453
Giddings, J Calvin 'Eddy' Diffusion in Chromatography, 357
Giese, Arthur C (edited by Victor E Hall, in association with Frederick A Fuhrman and) Annual Review of Physiology, Vol 21, *review* by Prof D C Harrison, 838
Gifford, Jr , Ernest M (Foster, Adriance S and) Comparative Morphology of Vascular Plants, *review* by Dr S Williams, 84
Gifford, Prof George E (Blakey, Billy R , and) Discarded Blood Bank Blood as a Source of Protein for Cultivation as HeLa Cells, 1158
Gifkins, R C Atomic Mechanisms of Fracture (Creep Fracture), 325
Gilbert, K R A History of Western Technology, *review*, 1601
Gilbert, Dr Lawrence I , and Schneiderman, Dr Howard A Prothoracic Gland Stimulation by Juvenile Hormone Extracts of Insects, 171
Giles, C G Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 858 , work of, 858
Giles, jun , Lester A , and Mann, John W . Oil Pollution of the Sea (Recommendation that the United States accept the 1954 Convention), 950
Giletti, Dr Bruno J Rubidium-Strontium Ages of Lewisian Rocks from North-West Scotland, 1793
Gill, D A Retirement as chief of the Division of Animal Health and Production of the Commonwealth Scientific and Industrial Research Organization, 1532 , work of, 1532
Gill, D A (White, Dr F W G , and) *Obituary* of Sir Ian Clunies-Ross, 230
Gill, P J , and others Magnetic Effects resulting from Two High-Altitude Nuclear Explosions, B A 34
Gillbright, Dr M Polar Front Survey—Biology (Productivity), 1183 , (Distribution of Phytoplankton, Zooplankton and Organic Particles on a section between Newfoundland and the Azores), 1183
Gilles, A , et autres Recherches sur l'Autostérilite du Cafeier robusta (*Coffea canephora* Pierre), 518
Gillespie, I E Appointed lecturer in surgery in the University of Sheffield, 410
Gillespie, Dr J E O'N , and others A Haemoglobin with Unusual Alkaline-denaturation Properties in a Turkish-Cypriot Woman, 1876
Gillespie, J M , and others Structure and Chemistry of Proteins (Methods of Splitting Disulphide Bonds and their Application in the Extraction of Soluble Proteins from Wool), 1277
Gillespie, Dr J S Appointed the first Sophie Fricke Royal Society Research Fellow in the Rockefeller Institute, 595
Gillett, Dr J D Control of Hatching in the Prediapause Eggs of *Aedes* Mosquitoes, 1621
Gillis, Dr R G (compiled by) The Intensity of Infra-red Absorption Bands—a Bibliography, 682
Gilmore, J E , and others A Suspected Virus Disease of the Citrus Red Mite *Panonychus citri* (McG), 70
Gilpin-Brown, Dr J B (Denton, Dr E J , and) Buoyancy of the Cuttlefish, 1330
Gilson, P , et autres Carte des Sols et de la Vegetation du Congo Belge et du Ruanda-Urundi, 6, Yangambi, Planchette 3, Lilanda, A, Sols, B, Vegetation (Institut National pour l'Etude Agronomique du Congo Belge), 27
Gilzin, Karl Sputniks and After (translated from the Russian by Pauline Rose), *review* by D G King-Hele, 836
Gimeno, A , and others Histological Localization of Fluorescent Thyroid-stimulating Hormone in Rat Tissues, 1733
Gimeno, Alvaro L , and others The C_{17}-OH Group of Œstradiol—Relationships between its Anti-Atherogenic and Endocrine Actions, 1720
Ginkgo biloba Vein Anastomoses in the Leaves of Long Shoots of (Dr Howard J Arnott), 1336
Ginzburg, Dr B Maintenance of Semi-permeability of Plant Cell Membranes in the Absence of Metabolic Energy Supply, 1073
Ginzel, Dr K H Are Mucosal Nerve Fibres Essential for the Peristaltic Reflex?, 1235

Giovanella, B , and others Degradation of Thiotaurine by Ionizing Radiations, B A 61
Giraldi, Dr P N , and others Sulphonamides with Diuretic Activity, 1711
Girardet, Prof A La science, le savant et le pharmacien (Presidential Address to the Swiss Society for Natural Sciences), 1454
Girdler, Dr R W Possible Reversals of the Earth's Magnetic Field in the Jurassic Period, 540
Giustina, A , and others Rôle of Stroma in Haemoglobin Synthesis—Experiments on Duck Red Cells *in vitro*, 1878
  Pathway of Carbon-^{14} Incorporation from NAH^{14}CO$_3$ to Haem in Duck Blood incubated *in vitro*, 1879
Given, Dr P H Coal Science (Chemical Reactions of Coal), 413
  Structure of Bituminous Coals—Evidence from Distribution of Hydrogen, 980
Given, Dr P H , and Peover, Dr M E Hydrogenolysis of Carbon-Oxygen Bonds in some Aromatic Compounds by Electrolysis, 1064
Glacial (Irish Late-) *Lepidurus arcticus* in the (Dr M E S Morrison), 739
Glacier Ice (Antarctic) Creep Tests on (Malcolm Mellor), 717
Glacierization Indications of, in the Siwalik System in India (R C Mehridatta), 833
Glanber, Prof R J Nuclear Forces and the Few-Nucleon Problem (Scattering of Nucleons by Light Nuclei at High Energy), 1113
Gland (Anterior Pituitary) A Dense Laminar Structure found in Conjunction with Cell Membranes in the (Barbara G Barnes), 651
Gland (Ferret Pituitary) A Nucleus of Nerve Cells in the (Dr R L Holmes), 1819
Gland (Human Pituitary) Structure of a Melanocyte-stimulating Hormone from the (Dr J Ieuan Harris), 167
Gland (Nasal) (Salt Gland) Captive Marine Birds possessing a Functional Lateral (Prof Larry Z McFarland), 2030
Gland Stimulation (Prothoracic), by Juvenile Hormone Extracts of Insects (Dr Lawrence I Gilbert and Dr Howard A Schneiderman), 171
Glands (Cholinergically Innervated Sweat) Response of, to Adrenaline and Noradrenaline (Dr David P C Lloyd), 277
Glands (Salivary), of the Brown Ear Tick, *Rhipicephalus appendiculatus* Neumann New Cell Types in the (Dr W M Till), 1078
Glands (Thyroid) Accumulation of Radioactive Iodine in, subsequent to Nuclear Weapon Tests and the Accident at Windscale (Dr Hamish A Robertson and Ian R Falconer), 1699
Glands (Total Mammary), of the Mouse Organ Cultures of (Dr F J A Prop), 379
Glaser, Dr D A Development of Bubble Chambers and some recent Bubble Chamber Results in Elementary Particle Physics (Charles Vernon Boys Prize Address to the Physical Society), 954
Glass, Prof H Bentley (edited by) A History of Nutrition (Prof Elmer Verner McCollum), *review* by Dr Leslie J Harris, 484
Glass, Prof H Bentley, and others Statement on Biological and Chemical Warfare, 1018
Glass The Structure of—Proceedings of a Conference held at Leningrad, 1953 (translated from the Russian by E B Uvaroc), *review* by Prof R W Douglas, 134
Glass in Aqueous Systems Strength Impairment Mechanism of (Frederick J Radd and Donald H Oertle), 976
Glass Electrodes Alkali Ion Determinations by means of (Research Symposium at the University of Sheffield), 1616
Glass Fibres Strength of (J G Morley), 1560
Glass Industry Research Association, British New Laboratories of the, 775
Glass Melting The Development of Furnaces for (Dr W M Hampton), 772
Glass Micro-Electrodes for Measuring Intracellular Activities of Sodium and Potassium (Dr J A M Hinke), 1257
Glass-Paper Chromatography Specific and Sensitive Assay Method for Vasopressin and Oxytocin using (Akira Arimura and Prof Joseph F Dingman) 1874
Glass Technology at Sheffield, 1271
Glass Technology (Society of Glass Technology), 855
Glass Technology, Society of The *Journal* to be published in two parts—*Glass Technology* and *Physics and Chemistry of Glasses*, 855
Glasscock, Dr H H *Obituary* of Prof E S Salmon, 1188
Glasses Non-Oxide (Bell Telephone Laboratories), 594
Glasses, Physics and Chemistry of (Society of Glass Technology), 855
Glasshouse Crops Research Institute Annual Report for 1957, 161
  Open Day (F W Toovey), 1033
Glaucoma Species in the Central Nervous System of the Carp (Prof A Stolk), 1737
Glaz, E T , and others A New Trichothecin-like Antifungal Antibiotic, 908
Glazenburg, S Oil Pollution of the Sea (Disposal of Oil Waste and Facilities in Ports), 950
Gledhill, Dr A W Germ-free Vertebrates—Present Status, 1541
Glentworth, R Conservation in the Scottish Highlands (Soil Conditions in the Highland Areas), 1529
Glew, Dr D N Some Stoicheiometric Gas Hydrates, 545
Glial Cells (Isolated, Fresh Nerve Cells and), from Control and Stimulated Animals Quantitative Assay of Compounds in (Prof Holger Hyden), 433
Glinski, Dr G Self-Regulation in Living Systems (Stability and Adaptability of Multi-loop Feedback Control Systems), 240
Glioblastoma (Human Multiform) Electron Microscopical Structure of the Wall of Small Blood Vessels in (Dr S H M Nystrom), 65
Glišin, Vladimir R , and others Fate of the Highly Polymerized Spleen Deoxyribonucleic Acid labelled with Pnosphorus-32 Injected Intraperitoneally into Rats, 1818
Globular Clusters A Search for Neutral Atomic Hydrogen in (Dr Morton S Roberts), 1555
Globulin (Antibody) *In vitro* Labelling of, by Tritium Exchange (Dr P C Rajam and Anne-Louise Jackson), 375
γ-Globulin (Human) Staphylocoagulase Inhibition by Pooled (Prof Murray M Streitfeld, Prof Bennett Sallman and Seymour M Shoelson), 1665
γ-Globulin (Rabbit) *Iso*-Antigens of (S Dubiski, Danuta Skalba, Anna Dubiska and Dr A Kelus), 1811
β-Globulin Alleles in some Zebu Cattle (G C Ashton), 1135
Globulins Production of Serum Albumin and of, by Chick Mesenchymal Tissue and by HeLa Tumour Tissue in Culture (Y Abdel-Samie, Prof E Broda, G Kellner and W Zischka), 361, *erratum*, 943
γ-Globulins (Fast-Moving) Separation of, by Starch-Gel Electrophoresis (Dr M D Poulik, Dr W W Zuelzer and Dr R Meyer), 1800
γ- and α-Globulins Production of, by the Isolated and Perfused Rat Spleen (Dr E Espinosa), 1801
Glockler, G Thermodynamics (Experimental Thermochemistry), 1608
Gloeosporium in Apple Stem Wounds (R O Sharples), 243 , (A T K Cooke), 244
Glossopteridean Fructifications (Presumed) Occurrence of, in Rhodesia and Nyasaland (Dr William S Lacey), 1592
Glove Boxes and Shielded Cells for Handling Radioactive Materials—a Record of the Proceedings of the Symposium on Glove Box Design and Operation held in the Cockcroft Hall, A E R E , Harwell, 1957 (edited by G N Walton), *review*, 1599
Glover, F A (Gibbons, Dr R A , and) Flow Properties of Biological Systems (Measurements of Flow Birefringence), 1540
Glover, Peggy, and others Fluorescent Schiff-Type Reagents for Cytochemical Detection of Polyaldehyde Moieties in Sections and Smears, 1797
Glucosamine Synthesis Interfering Substances in the Determination of (Dr Fiorenzo Paronetto), 1317
Glucose Changes in Adenosine Di- and Tri-phosphate Concentrations in the Early Stages of the Action of Yeast on (Dr J O Laws and Dr L H Stickland), 1246
Glucose-6-phosphate Dehydrogenase Characteristics of, from Normal and Primaquine-sensitive Erythrocytes (Glucose-6-phosphate Dehydrogerase and Human Erythrocytes), (Dr Henry N Kirkman), 1291
Glucose-6-phosphate Dehydrogenase and Human Erythrocytes—Characteristics of Glucose-6-phosphate Dehydrogenase from Normal and Primaquine-sensitive Erythrocytes (Dr Henry N Kirkman), 1291 , Mechanism of Inactivation of Glucose-6-phosphate Dehydrogenase in Human Erythrocytes (Dr Paul E Carson, Stanley L Schrier and Robert W Kellermeyer), 1292
Glucose-6-phosphate Dehydrogenase in Human Erythrocytes Mechanism of Inactivation of (Glucose-6-phosphate Dehydrogenase and Human Erythrocytes), (Dr Paul E Carson, Stanley L Schrier and Robert W Kellermeyer), 1292
Glucosyl Oligosaccharides (Liver), and Glycogen—Carbon-14 Dioxide Experiments with Hydrocortisone (Dr Hsien-Gieh Sie, Prof James Ashmore, Dr Robert Mahler and Prof William H Fishman), 1380
Glucuronic Acid (4-0-Methyl), in *Rhizobium* Gums Occurrence of (Beverley A Humphrey), 1802
β-Glucuronidase Localization of, in Normal and Cancer Cells (J Conchie and Dr G A Levvy), 1709
β-Glucuronidase Activity (Urinary), in Patients with Bone Fractures (F J W Lewis and Dr Constance H J Plaice), 1249
Glutamic Dehydrogenase of Mung Bean Mitochondria (Dr D H Bone), 990
Glutamic-Pyruvic Transaminase in Rabbit's Long Bones (L Tessari and L Parrini), 904
Glutamo-Transferase A Non-Dialysable Inhibitor of, present in Excised Tomato Roots (C S Vaidyanathan and Prof H E Street), 347
Glutathione Stability of the Erythrocytes in Iranians (Dr D G Walker and Dr J E Bowman), 1325
Glutathione (Rat Brain), and Pyridoxine Deficiency (M J Ashwood-Smith and A D Smith), 2028
Glutathione and Total Free Sulphydryl (Cystine-Cysteine,) , Contents of, in Arsenic-resistant and Sensitive Strains of the Blue Tick, *Boophilus decoloratus* (Dr J S Harington), 1739
Glyceraldehyde-3-phosphate Dehydrogenase Rôle of the Co-enzyme in the Stabilization of (P Elodi and G Szabolcsi), 56
Glyceric Acid in Broad Bean (*Vicia faba* L), (R I Morrison and Dr P C. Dekock), 819
Glycerol Possible Rôle of in the Winter-Hardiness of Insects (P Dubach, D Pratt, Prof F Smith and C M Stewart), 288
Glycerol-extracted Muscle Fibres Oxygen Uptake of (James A Wilson, Paul R Elliott, Prof Karl F Guthe and David G Shappirio), 1947
I-Glyceryl-2-*myo*-inositol Phosphate Synthesis and Properties of (Dr T Malkin), 789 , Synthesis of I-Glyceryl-2-*myo*-inositol Phosphate (J H Davies and Dr T Malkin), 789 , I-Glyceryl-2-*myo*-inositol Phosphate—Alternative Synthesis and Behaviour on Hydrolysis (R B Ellis and J N Hawthorne), 790
Glycogen Liver Glucosyl Oligosaccharides and—Carbon-14 Dioxide Experiments with Hydrocortisone (Dr Hsien-Gieh Sie, Prof James Ashmore, Dr Robert Mahler and Prof William H Fishman) 1380
Glycogen Level (Liver), of Normal and Adrenalectomized Mice Effect of Diet on the Blood Sugar and (B P Block and Dr G S Cox), 721
Glycolaldehyde Trapped from Aerobic Oxidation of D-Xylose by *Torulopsis utilis* (V Bolcato and G Leggiero), 1318
Glycolytic Enzyme System Rôle of the, in the Germination of Spores of *Bacillus coagulans* var *thermoacidurans* (Prof Mikio Amaha and Tomoko Nakahara), 1255
Glycoproteins of Human Cerebrospinal Fluid (Dr Samuel Bogoch), 1628
Glycosidases in the Mammalian Alimentary Tract (J Conchie and D C Macdonald), 1233
Glycoside of the Root of *Marsdenia erecta* R Br Sugars of the (Dr T Baytop Dr M Tanker, Dr N Öner and Dr S Tekman), 1319
(α- and β-) Glycosides A Method for Distinguishing between, by the use of Plant Haemagglutinins (Lectins), (Dr A Makelã), 111
Glycosides (Sterol), in Oilseed Phospholipids (Dr Francis Aylward and B W Nichols), 1319
Glyptotendipes (Phytotendipes) paripes Edwards Copulation of (Dr Eric T Nielsen), 1252
Gneiss (Pre-Cambrian) of Ongul Islands in the Antarctic Natural Remanent Magnetization of (T Nagata and Y Shimizu), 1472
Goddard, Dr C K , and others Force-Feeding Fish under Experimental Conditions, 1660
Goddard, J , and others A Theory of the Abrasion of Solids such as Metals, 333
Goddard, Dr L S Foundations of Set Theory, *review*, 1178
  Axiomatic Set Theory, *review*, 1178
  Linear Operations and Classical Analysis, *review*, 1763
  Mathematics and Operations Research, *review*, 1763
Godfraind, R L'Auto-Intoxication apres Brûlure, *review* by Dr S Sevitt, 5
Godfrey, J W , and Parr, G The Technical Writer, *review* by A L Bacharach, 1749

Godhavn, Greenland Observations of 'Whistlers' and Very Low Frequency Phenomena at (Eigil Ungstrup), 806
Godridge, A M, and others Studies of Coal—Carbonization of Coals in the Presence of Activated Charcoal, 425
Godwin, Dr H Radiocarbon Dating, 674
 Carbon-dating Conference at Groningen, September 1959, 1365
Godwin, Dr H, and Willis, Dr E H Radiocarbon Dating of Prehistoric Wooden Trackways, 490
Golaszewski, T, and others Cytoplasmic Nucleopeptides in Guinea Pig Liver, 1940
Gold, Dr V Principles of Electrolysis, *review*, 1902
 Principles of Oxidation and Reduction, *review*, 1902
Au (Coinage Metals, Cu, Ag,) Electron Spin Resonance and Divalency of some Dithiocarbamates of the (Tore Vänngard and Stig Åkerstrom), 183
Gold in a Mercury Electrode Influence of, on certain Electrode Processes (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus), B A 56
Gold Medal of the Illuminating Engineering Society awarded to Dr J W T Walsh, 1106
Gold (Silver and), in the Fowl Semi-Albino, a Third Sex-linked Allelomorph of (W F Werret, A J Candy, J O L King and Dr P M Sheppard), 480
Goldacre, Dr P L, and Bottomley, Dr W A Kinin in Apple Fruitlets, 555
Goldacre, Dr R J, and Sylvén, Dr B A Rapid Method for Studying Tumour Blood Supply using Systemic Dyes, 63
Goldberger, —, and others Nuclear Forces and the Few-Nucleon Problem (Scattering of Nucleons by Light Nuclei at High Energy), 1113
Goldsmith, J A At the first Conference of the British Computer Society (Installations of Electronic Computers in the United Kingdom), 946
Goldup, Dr A Gas Chromatography (Potentialities of the new Coated Capillary Columns in the Petroleum Industry), 328
Golnow, Dr H At the Second Australian Spectroscopy Conference (A Precision Photoelectric Setting Device for the Measurement of Diffuse Spectral Lines), 1197
Golovin, Dr I N Thermonuclear Processes (Magnetic-Mirror Systems in the Soviet Union), 241
Gonadal Cycle in an Equatorial Bird, *Quelea quelea* Effect of Photoperiod on the (Dr Albert Wolfson and David P Winchester), 1658
Gonadotrophin (Urinary) Preparation of a Highly Purified Sample of the (Roland Bourrillon, René Got and Rene Marcy), 983
Gonfiantini, Dr R, and Picciotto, Prof E Oxygen Isotope Variations in Antarctic Snow Samples, 1557
Gonzalez, Prof G, and others A Lesion of the Follicle and of the Fibre of Wool and its Possible Relation with an Excess of Iron in the Forage, 559
Good, Prof Ronald Causes de la Repartition des Etres Vivants, *review*, 390
 Retirement from the chair of botany in the University of Hull, 853, work of, 853
 Panbiogeography, *review*, 924
Gooddy, Dr William Animal Clocks, 765
Goodford, P J Awarded a Senior Studentship by the Royal Commission for the Exhibition of 1851, 409
Gough, Dr K R Appointed Research Fellow in medicine at the University of Bristol, 1613
Goodman, Gordon T, and Perkins, Donald F Mineral Uptake and Retention in Cotton-Grass (*Eriophorum vaginatum* L), 467, *erratum*, 1845
Goodman, N S, and Siegel, S M Reaction-directing Properties of Non-enzymic Macromolecules—Pyrogallol Oxidation in the System Iron (III)–Cellulose, 53
Goodwin, Prof T W Appointed to the chair of agricultural chemistry in the University College, Aberystwyth, 318, work of, 318
Goodwin, Prof T W (Seybold, A, and) Occurrence of Astaxanthin in the Flower Petals of *Adonis annua* L, 1714
Goodyear, Dr J, and Duffin, Dr W J Clay Minerals (Studies on Scarbroite), 780
Goranov, Prof Iv, and others Agar Electrophoresis of Normal Soluble Proteins in Guinea Pig Liver, B A 64
Gorchakovsky, P Origin and Dispersal of Flowering Plants (Ural Flora composed of relics from Pre-Glacial Broad-leaved Forests and Glacial ones), 1200
Gordon, Colonel D H The Pre-historic Background of Indian Culture, *review* by M C Burkitt, 131
Gordon, R M, and Lavoipierre, M Delayed Hypersensitivity (Immediate and Delayed Reactions to Insect Bites), 1030
Gorham, P R (Nelson, C D, and) Translocation of Carbon-14-labelled Amino-Acids and Amides in the Stems of young Soya Bean Plants, 855
Gorman, L A, and others X-Ray Diffraction Pattern of Carbide in Low-Carbon Iron-Silicon Alloys, 1862
Gorrie, R M Conservation in the Scottish Highlands (Soil Erosion in Scotland), 1529
Gorshkova, Dr T I Polar Front Survey (Hydrography—Greenland and Norwegian Seas), 1181
Gosland, L *Obituary* of Dr Felix Busemann, 150
Gossling, B S Effects of the Energy of Strong Pulses of Ionic Current on Micro-organisms in Suspension, 1881
Got, René, and others Preparation of a Highly Purified Sample of the Urinary Gonadotrophin, 983
Gottlieb, Otto Richard, and others Phylogeny of the Genus *Aniba* Aubl — a Comparative Morphological and Chemical Observation, 1589
Gottschalk, Dr Alfred The Moving Front of Carbohydrates, *review*, 662
Gouriet, G G Colour Television (Christmas Holiday Lecture of the Institution of Electrical Engineers), 1535
Goutier, R, and others Biological Effects of Low Doses of Ionizing Radiations (An Effect which occurred soon after the Comparatively Low Dose of 150 r (whole-body) to Rats), 1112
Goutier-Pirotte, M, and others Biological Effects of Low Doses of Ionizing Radiations (An Effect which occurred soon after the Comparatively Low Dose of 150 r (whole-body) to Rats, 1112
Government The Profession of (Dr Brian Chapman), 1087
 The Profession of—the Public Service in Europe (Dr Brian Chapman), 127
Government Research and Development Expenditure in Britain Control of, 696
Government Scheme Research for Industry 1958, a Report on Work done by the Industrial Research Associations in the (Department of Scientific and Industrial Research), 211, 238
Gowans, J L Delayed Hypersensitivity (Participation of Leucocytes in the Transference of Specific Delayed Hypersensitivity—Life-history of Lymphocytes), 1030
Gozna, C F, and others Ionization Phenomena in Gases (State of the Cathode on Growth Times and Sparking Potentials in Hydrogen), 1354
Grabar, Dr P, and others Immunochemical Studies of Polypeptidyl Proteins and Synthetic Polypeptides, 549
Grace and Co, W R Grant of 6,000 dollars for two years to the University of Leeds, for a research fellowship in physical chemistry, 1108
Gracian, J, and others Quantitative Estimation of the Fatty Acids of Olive Oil, 1941
Gracie, Dr D S *Obituary* by Dr W Lawrence Balls 315
Gradient (A Concave Concentration), of Methanol in Chloroform employed in Elution of Lipids from Silicic Acid (J J Wren), 816
Gradient Synchrotron (Zero), at Argonne National Laboratory, 503
Graduate School in Mathematical Physics at Birmingham (Prof R E Peierls), 96
Graduate Studies A University of (Dr Detlev W Bronk), 86
Graduates (University) A Career in Education for (Ministry of Education), revised edition, 1777
Graduates and National Service, 406
Graf, L Ionization Phenomena in Gases (Breakdown Potential Measurements for a c Fields), 1354
Grafts (Subcutaneous Thymus), in Thymectomized Mice Inoculated with Leukaemic Filtrate Fate of (J F A P Miller), 1809
Graham, A Ergonomics, its Place in Industry, B A 21
Graham, Dr Angus F The Structure of Science (Cell-Virus Relationships and the Methodology of their Analyses), B A 9
Graham, Brice, and others (C F H Allen, in collaboration with) Six-Membered Heterocyclic Nitrogen Compounds with Three Condensed Rings *review* by Dr F G Mann, 216
Graham, D C The Customs and Religion of the Ch'iang, B A 15
Graham, Dr G R, and others 'Supercarbia' in the Anaesthetized Dog, 1071
Graham, J K L Rock Pressure in Mines, *review*, 1349
Graham, Prof Kenneth Release by Flight Exercise of a Chemotropic Response from Photopositive Domination in a Scolytid Beetle, 283
Grain Boundary Carbides found in Austenitic Stainless Steel Chromium Distribution around (B E Hopkinson and K G Carroll), 1479
Grain Boundary Reaction in Aluminium–Zinc Alloys Reversion of Nodules formed by the (Ryoji Watanabe and Shigeyasu Koda), 977
Gram, Ernst, and others Recognition of Diseases and Pests of Farm Crops, *review* by F C Bawden, 1258
Gram-Positive Bacteria Characters associated with Parasitism in (Dr K A Bisset), B A 29
Gramineae Inflorescence Inception and Leaf Size in (M Borrill), 321
Gramophone From Tinfoil to Tape—the History of the (John Cain), 1535
Grana (Respiratory) Cancer and the (Prof Carl C Lindegren), 397
Granicher, H, and Jaccard, C Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 157
Granite Anomalous 'Common Strontium' in (W Compston and Dr P M Jeffery), 1792
Grant, Prof C K Science and Scepticism, *review*, 1975
Grant, H L, and others A Spectrum of Turbulence at Very High Reynolds Number, 808
Grant, Dr Julius Fundamentals of Papermaking Fibres, *review*, 1011
Grant, Dr J K Biosynthesis and Secretion of Adrenocortical Steroids, 415
Grant, M W Food for Survival after a Disaster, *review*, 841
Grant, Dr N (Loukashkin, Dr A S, and) Behavior and Reactions of the Pacific Sardine, *Sardinops caerulea* (Girard), under the Influence of White and Colored Lights and Darkness, 865
Grant, N J Atomic Mechanisms of Fracture (Creep Fracture), 325
Grant, Dr P J Appointed reader in engineering science at the Imperial College of Science and Technology, 322
Grant, V Origin and Dispersal of Flowering Plants (Diversity of Pollination Systems in the Polemoniaceae), 1200
Grants (Josiah Macy Jr Foundation), 683
Grants Research (Australian Atomic Energy Commission), 940
 Research Fund (Chemical Society), 857
Grants for Private Philanthropic Foundations in 1957 (United States National Science Foundation, Reviews of Data on Research and Development, No 15), 1272
Grants-in-aid for Research in Problems of Sex (United States National Academy of Sciences—National Research Council), 1107
Grants (Travel), under the Fulbright Programme, 1273
Grants (University), in Great Britain, 1118
Grants Year Book, 1959 (National Union of Students), 770
Granules in the Cytoplasm of Tumour-Cell Cultures in Contact with Lysozyme Appearance of (Dr Carlo Callerio), 202, *erratum*, 508
Granules (Potato Starch) Physical and Chromatographical Observations of γ-Irradiated (Akira Mishina and Ziro Nikuni), 1867
Graphitic Form of Hexagonal Boron Nitride Transformation of a Cubic Boron Nitride to a (H Judith Milledge, E Nave and F H Weller), 715
Grass Productivity (André Voisin), translated from the French by Catherine T M Herriot, *review* by Dr W Davies 1675
Grass (Cotton-), *Eriophorum vaginatum* L Mineral Uptake and Retention in (Gordon T Goodman and Donald F Perkins), 467, *erratum*, 1845
Grasses (Educational Productions, Ltd, Filmstrip CX 6332), 1777
Grasshopper Eggs kept for Long Periods in Mineral Oil Survival of (Prof Eleanor H Slifer), 1424
Grassland Management, *review* by Dr W Davies, 1675
Grassland Productivity The Measurement of (Sixth Easter School in Agricultural Science at the University of Nottingham School of Agriculture), 154
Grassland Research Institute Annual Report for 1957-58 (Experiments in Progress, No 11), 1370
Graticules, Ltd The 'England Finder', 34
Grating Spectrometers (Wide-range) Resolution of (Dr A E Martin), 975
Gratzer, W B (Beaven, Dr G H, and) Direct Spectroscopic Examination of Electrophoretic Zones in Agar Gel, 359
 Foetal Haemoglobin in the Monkey, 1730
Gratzer, W B, and others A Haemoglobin with Unusual Alkaline-denaturation Properties in a Turkish-Cypriot Woman, 1876

Gray, Prof C H , and others Optical Activity of Stercobilin and *d*-Urobilin, 41
Gray, Dr Clarke T , and others Inhibition of Urease by Alloxan and Alloxanic Acid, 1936
Gray, Dr G W (edited by) Steric Effects in Conjugated Systems—Proceedings of a Symposium held at the University, Hull, 1958, by the Chemical Society, *review* by Dr G Eglinton, 1522
Gray, Sir James The Proper Study of Mankind is Man (Presidential Address to the British Association for the Advancement of Science), B A 35
Gray, J Origin and Dispersal of Flowering Plants (Angiosperms in various Tertiary Floras of Oregon), 1201
Gray, Dr Peter Explosions in Solids, *review*, 664
Grayson, J F , and Pierce, R L Origin and Dispersal of Flowering Plants (Low Representation of Angiosperms in two American Cretaceous Floras), 1201
Grazing Cattle A Relationship between Weight of Internal Fat, 'Fill', and the Herbage Intake of (J C Tayler), 2021
Greacen, E L Swelling Forces in Straining Clays, 1695
Great Britain Memoirs of the Soil Survey of—England and Wales , The County of Anglesey—Soils and Agriculture (E Roberts), (Agricultural Research Council), 154
  Myxomatosis—Present Position and Future Prospects in (Dr C H Andrewes, H V Thompson and W Mansi), 1179
  Productivity Measurement in (T E Easterfield), 592
  Progress in Coke Research in, 1778
  River Flow in (F W H Green), 210
  Scientific Research in, 1897
  Scientific and Engineering Man-power in, 1959 (Report of the Committee on Scientific Man-power of the Advisory Council on Scientific Policy), 1982
  Sponsored Research in, 235
  Thermonuclear Research in (Physical Society Conference on), 1015
  University Grants in, 1118
  Water Supply and Demand in (Prof W G V Balchin), B A 18
  See also under Britain
Great Britain and Ireland Handbook of the Rubi of (the late W C R Watson), *review* by R D Meikle, 489
Great Britain and Northern Ireland Statistics of Public (Rate Supported) Libraries in, 1957-1958 (Library Association), 592
Great Britain (United States and), to exchange Data on Advanced Gas-cooled Reactors, 1361
Great Depression Lancashire Livestock Farming in the (T W Fletcher) 1916
Great Earthquakes and the Astronomical Positions of Uranus (Prof A Tomaschek), 177
Great Lakes Geology of the (Prof Jack L Hough), *review* by Prof S E Hollingworth, 665
Grebenik, Prof E Marital Fertility in England and Wales, 1035
Greece in Medical History Egypt and, *review* by Dr Douglas Guthrie, 662
Green, A F , and others New Antiadrenergic Compounds, B A 70
Green, Dr A T Retirement from the directorship of the British Ceramic Research Association, 1843 , work of, 1843
Green, Mr and Mrs C H Gift of 2,527,500 dollars to the Massachusetts Institute of Technology, 507
Green, Prof D E Energy Transfer with special reference to Biological Systems (Electron Transport is essentially a Solid-State Process occurring in a Lipid Phase), 690
Green, Edie J Nature Conservation and Youth Service in Britain, 685
Green, F H W River Flow in Great Britain, 210
Green, F W Effects of Forest Areas on Water Resources, and the Technique of Lysimeters—Lysimeters, 1186
Green, J , and others Tocopherols in Micro-organisms, 1339
Green, L V Ergonomics, its Place in Industry, B A 21
Green, M M Effect of Different Wild-Type Isoalleles on Crossing-over in *Drosophila melanogaster*, 294
Green Algae Chloroplast Pigments of Deuterated (Harold H Strain, Henry L Crespi and Joseph J Katz), 730
Greenberg, Prof Leo, and Ingalls, Dr James W Effect of Tranquillizing Drugs on Survival from Experimental Diphtheric Intoxication, 1721
Greenberg, Dr Samuel M , and others Effect of Ethylenediamine Tetra-acetate on Vitamin B_{12} Absorption in the Rat, 1948
Greene, H Carleton Two Threats to Broadcasting—Political and Commercial Control, 661
Greene-Kelly, R Birefringence of Montmorillonite Complexes, 181
Greenfield, S Chemistry of Propellants (Experimental Evaluation of Liquid-Propellant Data), 778
Greenfinches Diffusion of a New Habit among (Dr Max Pettersson), 649
Greenhow, E J , and Smith, J W Coal Science (Chemical Reactions of Coal), 413
Greenland Observations of 'Whistlers' and Very Low Frequency Phenomena at Godhavn, (Eigil Ungstrup), 806
Greenough, James J , and others Thirst for Bile in Rats with Bile Fistulae, 1405
Greenwich Time Ball at, 318
Greenwood, H M *Obituary* by Dr W D Jones, 404
Greenwood, N N Thermodynamics (Experimental Thermochemistry), 1607
Greenwood, T T, and others Cross-linking of Cellulose Acetate by Ionizing Radiation, 1303
Gregg, S J , and Pope, M I Coal Science (Ultra-fine Structure of Coals and Chars— Effect of Pressure and of Exposure to Atmospheres of various Humidities on the Electrical Conductivity of Coal Artefacts), 413
Gregoire, Dr Ch Conchiolin Remnants in Mother-of-Pearl from Fossil Cephalopoda, 1157
Gregor, Z , and Křivsky, L Changes in the Climate of the Atlantic–European Area and Secular Solar Activity, 682
Gregory, H R , and others Compaction of Briquettes, 120
Gregory, Dr T S Appointed chief of the Division of Animal Health of the Commonwealth Scientific and Industrial Research Organization, 1532 , work of, 1532
Greig, Prof J *Obituary* of R P Howgrave-Graham 92
  British Electrical and Allied Industries Research Association, 1538
Cresford, G B Appointed secretary of the Australian Commonwealth Scientific and Industrial Research Organization, 1985 , work of, 1985
Gresham, Dr G A , and Cruickshank, J G Protein Synthesis in Macrophages containing *Eimeria tenella*, 1153
Gresswell, R K Coast Erosion and Accretion, 501
Griem, H R , and Kolb, A C Ionization Phenomena in Gases (Improved Methods of Calculating Stark Broadening of Spectral Lines), 1357
Grieveson, P , and Alcock, Dr C B Special Ceramics (Measurements of the Dissociation Pressures of Metallic Silicides and of Silicon Carbide) 1116
Griew, Dr S Ergonomics, its Place in Industry, B A 22
  Appointed lecturer in psychology at the University of Bristol, 1613
Griffin and George, Ltd New branch opened at Newcastle-upon-Tyne, 1273
Griffith, Dr R H , and Marsh, J D F Contact Catalysis, *review* by Dr E B Maxted, 1262
Griffith, Dr T C , and Power, E A Nuclear Forces and the Few-Nucleon Problem, 1113
Griffiths, Dr H B Appointed lecturer in pure mathematics at the University of Birmingham, 1362, 1688
Griffiths, J W R Transistor Electronics, *review*, 838
Griffiths, Dr L A Detection and Identification of the Polyphenoloxidase Substrate of the Banana, 58
Griffiths, L B , and Pfeil, P C L Insulating Particles on Cathode Surfaces —their Effect upon Electrical Discharges, 1475
Griffiths, R E Personnel Management and Technological Change (Effect of Equal Pay on Employment Policies), 1614
Grigoriev, Prof D P Alpine Mineral Fissures (Origin of Quartz as a Fissure Mineral of the Alpine Type in the U S S R), 1910
Grimshaw, L Appointed lecturer in psychiatry at the University of Sheffield, 410
Grimstone, A V Awarded a Senior Studentship by the Royal Commission for the Exhibition of 1851, 409
Grinding Crushing and (Department of Scientific and Industrial Research), *review* by Prof S G Ward, 1177
Gripenberg Dr S Polar Front Survey (Hydrography—Chemistry of the Barents Sea Water), 1181
Griseofulvin Spectrophotofluorometric Assay of (Carole Bedford, K J Child and E G Tomich), 364
Groningen Carbon-dating Conference at, September 1959 (Dr H Godwin), 1365
Grootenhuis, Dr P Appointed to the University of London readership in mechanical engineering at the Imperial College of Science and Technology, 508
Grooved Stud Strength of a (D C Herbert), 897
Gros, F Specificity in Protein Biogenesis (Research on the Effects of Fluorouracil on Protein Synthesis in *E coli*), 1199
Gross, Dr D Two-Dimensional High-Voltage Paper Electrophoresis of Amino- and other Organic Acids, 1298
  High-Voltage Paper Electrophoresis of Aliphatic Amines and related Compounds, 1633
Grossbard, Dr Erna, and Stranks, Dr D R Translocation of Cobalt-60 and Caesium-137 by Fungi in Agar and Soil Cultures, 310
Grossfeld, Dr Henry Mechanism of the Atherogenic Action of Excess Hydrocortisone, 38
Grotzsch, Prof Herbert C Elected a member of the Mathematics Section of the Leopoldina Academy of Natural Sciences, 595
Ground-Based Radar in Meteorology Use of (excluding Upper-Wind Measurements), (World Meteorological Organization, Technical Note No 27), 942
Groundnut Effect on the, of Variations in Supply of Potassium, Calcium and Magnesium (Dr R Comber), 1003
Group (New), of Bacteria *Fasciculus limpidus* nov gen , nov spec , a Representative of a (Prof E G Pringsheim), 1098
Group and Type-specific Polysaccharides of Group D Streptococci (Dr S D Elliott), 1342
Groupings (Social), in Fishes Studies on (Dr C M Breder, Jr), 865
Groups (Oxygen-containing Functional), in the Organic Matter of a Podzol Soil (J R Wright and M Schnitzer), 1462
Groves, Dr G V Air Density in the Upper Atmosphere from Satellite Orbit Observations, 178
Groves, J R V , and others Spaced Observations of Radio Noise from the Outer Atmosphere, 1391
Growing Demand for Water First Report of the Subcommittee on the (Central Advisory Water Committee), B A 18
Growing Naked Protoplasts of Yeasts Nuclear Structure of (Dr O Necas), 1664
Growth Incorporation of Molecular Oxygen in Bacterial Cells utilizing Hydrocarbons for (E R Leadbetter and J W Foster), 1428
Growth of *Bacterium coli* and *Staphylococcus albus* in Heavy Water (Elizabeth van Horn and Dr G C Ware), 833
Growth of Cutaneous Melanoma in Killifish Hybrids Effect of Thiouracil and Thyroxine on Development and (Prof A Stolk), 562
Growth of Dermatophytes Effect of Steroids and related Compounds on the (Dr F W Chattaway, J D Townsley and A J E Barlow), 1731
Growth of *Euglena gracilis* A Biological Action of Deoxyribonuclease I on the (Dr Rudolf K Zahn), 1324
Growth of Pollen Tubes Effect of Gibberellin on the (Nanda Bose), 1577
Growth of Soil Micro-Organisms Factors in Forest-Tree Litter Extracts affecting the (Dr Roger Knowles and Edward Laishley), 1169
Growth of Staphylococci in Normal Human Serum Influence of Coagulase on the (Dr K Wlodarczek and Dr J Jeljaszewicz), 1514
Growth of *Striga* Seedlings Action of Inhibitor-β on the (C N Williams), 1577
Growth of *Ulothrix* Effects of Auxin and Gibberellic Acid on (Dr Herbert Conrad, Dr Paul Saltman and Dr Richard Eppley), 556
Growth of Wool Influence of Dietary Protein Percentage on (K A Ferguson), 907
  Measurement of the Rate of, using Cystine labelled with Sulphur-35 (A M Downes and A G Lyne), 1884
Growth, Flowering and Fruit Set in Sweet Potato Effect of Indole Acetic Acid and α-Naphthalene Acetic Acid on the (G Satyanarayana and Dr G Rangaswami), B A 73
Growth, Flowering, Nodulation and Nitrogen Assimilation of *Vicia villosa* Influence of Gibberellic Acid and Photoperiod on the (the late Prof Margaretha G Mes), 2035

Growth (Plant) Activities of 5- and 8-Halogeno- Dihydro- and Tetrahydro-1-naphthoic Acids (Toshio Fujita, Sadao Imai, Koichi Koshimizu, Tetsuo Mitsui and Jiro Kato), 1415
Growth (Plant-) Promoting Activity Isolation of Fatty Alcohols with, from Maryland Mammoth Tobacco (Dr A J Vlitos and Dr D G Crosby), 462
Growth (Plant) Regulation (Boyce Thompson Institute for Plant Research, the New York Botanical Garden and the Brooklyn Botanic Garden fourth International Conference on), 599
Growth (Plant) Regulators Interaction of, in Regeneration Processes (H Schraudolf and Prof J Reinert), 465
Growth (Plant) Substances (Prof L J Audus), second edition, *review* by Prof R L Wain, 925
Growth (Plant-) Substances and the Copper Chelating Theory of their Mode of Action (Dr C H Fawcett), 796
Growth (Top), of Cultivated Tea (Dr D N Barua), 1424
Growth (Tumour) Inhibition of, with 2 5-Dicarbethoxy-3 4-Dihydroxy-Thiophene (Dr M B Sahasrabudhe, M V Narurkar, L B Kotnis, B D Tilak and M D Bhavsar), 201
Growth (Unbalanced) Influence of, on Subsequent X-Ray Induced Inhibition of Deoxyribonucleic Acid Synthesis in *Escherichia coli* 15_T (Daniel Billen), 174
Growth-Controlling Action of Human Serum in Cell Culture (Dr Kari Penttinen and Dr Erkki Saxén), 1570
Growth Factors Unidentified (K A Allen, J Stephens, W P Jaffe and J A Wakelam), 271
  Unidentified Chick (J A Wakelam and W P Jaffe), 272
Growth Forms of Synthetic Diamonds Spiral and other—a Distinction between Natural and Synthetic Diamond (Prof S Tolansky and Dr I Sunagawa), 1526
Growth Inhibition of Mouse Ascites Tumour Cells by Powdered Tragacanth (Tragacanthae Pulvis, B P), (Dr E M F Roe), 1891
Growth Pattern (Cyclic), in *Neurospora* Genetic Control of a (Growth Patterns in *Neurospora*), (Dr D R Stadler), 170
Growth Patterns in *Neurospora*—A Biological Clock in *Neurospora* (C S Pittendrigh, Dr V G Bruce, N S Rosensweig and M L Rubin), 169 , Genetic Control of a Cyclic Growth Pattern in *Neurospora* (Dr D R Stadler), 170
Growth-Promoting Factor and a Tumour-Susceptibility Factor in Eggs Differentiation between a (Charles H Hill and Henry W Garren), 824
Growth Responses to Selenium in Lambs (Dr J W McLean, G G Thomson and J H Claxton), 251
Growth-Stage Floral Initiation and its Relationship to, in Red Clover (*Trifolium pratense* L), (J L Stoddart), 559
Growth and Reproduction Rate of *Paramecium multimicro-nucleatum* Effect of the Potassium Salt of Gibberellic Acid on the (A A Oravec, N G Strovilas, J L Beal and Arthur Tye), 1405
Growth and Variation Virus—Ninth Symposium of the Society for General Microbiology, London, 1959 (edited by A Isaacs and B W Lacey), *review* by N W Pirie, 920
Growth and Vitamin A Storage in the White Rat Effect of 'Amino-Acid Imbalance' on (M Rechcigl, jun , S Berger, J K Loosli and H H Williams), 1404
Grutzov, Dr L N (Pawstiks, Dr E A , and) Polar Front Survey (Biology —Distribution of Plankton in the Norwegian Sea), 1183
Guatemala Flora of (Paul C Standley and Julian A Steyermark), 771
Guérin, H , and Bastick, M Coal Science (Microporosity during Gasification of Coke between 800° and 1,000°C), 414
Guerritore, Prof Dino, and Bellelli, Luciano Interaction between Nucleic Acid and a Cationic Detergent, 1638
Guha, Dr Bhagawati Charan Temperature Variation of the Principal Magnetic Moments of Co^{++} Ions and the Asymmetry of the Crystalline Electric Field in Cobalt Acetate Tetrahydrate, 50
Guide (A Biochemist's), to the Nervous System, *review* by Dr G B Ansell, 1261
Guinea Pig Renewal Times of some Squamous Epithelia in the (H Platt), 1654
Guinea Pig Bone Marrow Cells which Synthesize Deoxyribonucleic Acid in, during Recovery from Whole-Body γ-Irradiation (P F Harris and J H Kugler), 1883
Guinea Pig Heart Sarcosomes Reversal by Acetylcholine of the Inhibition by Thyroxine of Oxidative Phosphorylation in (Heitor Medina and Metry Bacila), 1066
Guinea Pig Liver Agar Electrophoresis of Normal Soluble Proteins in (Prof Iv Goranov, Y Todorov, X Skatshokova, M Hlebarova and P Kuzmanova), B A 64
  Cytoplasmic Nucleopeptides in (P Szafranksi, S Sulkowski and T Golaszewski), 1940
Gulbenkian Foundation Help for the Arts, 699
Gullberg, Dr Ragnhild, and Olhagen, Dr Borge Electrophoresis of Human Gastric Juice, 1848
Gumbel, Prof E J Statistics of Extremes, *review* by R N Curnow 754
Gums (*Rhizobium*) Occurrence of 4-O-Methyl Glucuronic Acid in (Beverley A Humphrey), 1802
Gun Tunnel (Hypersonic) Measurement of the Effects of Piston Mass and Bursting Pressure on the Motion of a Piston in a (B J Belcher), 1207
Gunmetal A New Alloy for (Mond Nickel Co , Ltd), 1025
Gunn, Dr D L Retirement from the directorship of the International Red Locust Control Service, 589 , work of, 589
Gunn, Dr D L , and Symmons, P M Forecasting Locust Outbreaks, 1425
Gunne, Dr Lars-M Noradrenaline and Adrenaline in the Rat Brain during Acute and Chronic Morphine Administration and during Withdrawal, 1950
Gunstone, Dr F D Appointed senior lecturer in chemistry at St Salvator's College, St Andrews, 684
Gupta, Arati (Sharma, Dr Arun Kumar, and) Chromosome Breakage with Plant Pigments, 1821
Gurevitch, Dr B Possible Role of Higher Proprioceptive Centres in the Perception of Visual Space and in the Control of Motor Behaviour, 1219
Gutenberg, Prof B The Earth as Viewed in 1959, *review*, 1007
Gutfreund, Dr H Steric Aspects of the Chemistry and Biochemistry of Natural Products (Specificity of α-Chymotrypsin), 949
Guthe, Prof Karl F , and others Oxygen Uptake of Glycerol-extracted Muscle Fibres, 1947
Guthrie, Dr Douglas Egypt and Greece in Medical History, *review*, 662
Guthrie, Dr Mary J Tumourigenesis in Ovaries of Mice Transplanted to the Liver, Kidney and Adjacent Tissues, 916
Guthrie Lecture of the Physical Society (Prof W E Lamb), 954
Guttman, Dr P H (Kohn, Dr H I , and) Latent Period of X-Ray Induced Ageing—a Study based on Mortality Rate and Tumour Incidence, 735
Guttridge, C G (Thompson, P A , and) Effect of Gibberellic Acid on the Initiation of Flowers and Runners in the Strawberry, B A 72
Guy, R G , and others Structure of α-Hydroxyacetylene Complexes of Platinum (II), 526
Guy's Hospital Medical School, London Title of reader in therapeutics in the University of London conferred on Dr J H Trounce, 322
  Appointment of Dr D J Anderson to the University of London readership in physiology in relation to dentistry, 595
Gwynne, M D A Quick Method for Extracting Plant Embryos from certain Types of Seed, 1588
Gyimesi, J , and others A New Trichothecin-like Antifungal Antibiotic, 908
Gypsum Plaster Effect of Temperature on the Rate of Setting of (M J Ridge), 47

HAAS, F L (Doudney, C O , and) Effect of Purine and Pyrimidine Analogues on Reversion of a Tryptophan-requiring Strain of *Escherichia coli*, 114
Habenular, Interpeduncular and Dorsal Tegmental Nuclei A Heat-Loss Mechanism involving the (B G Cragg), 1724
Habit of Ice Crystals grown in Hydrogen, Carbon Dioxide and Air at Reduced Pressure (A P van den Heuvel and Dr B J Mason), 519
Habit (New), among Greenfinches Diffusion of a (Dr Max Pettersson), 649
Habitat (An Unusual Breeding), of the Linnet (N W Orford), 650
Habits (Blood-feeding), of Adult Noctuidae (Lepidoptera) in Cambodia (W Buttiker), 1167
Hackett, Dr D P (Niederpruem, Dr D J , and) Cytochrome System of *Streptomyces*, 1954
Hackman, R H Structure and Chemistry of Proteins (Properties of Protein Complexes of the Insect Cuticle), 1276
Haddow, Dr A J Animal Clocks (Influence of the Environment on the Cyclical Biting-Behaviour of Mosquitoes), 763
Haem Binding of, to Protein in Haemoglobin and Myoglobin (Dr J E Falk, Dr J N Phillips and Dr D D Perrin), 1651 , (Dr J E O'Hagan), 1652
  Decrease in Acid Strength of Propionate Side-chains of Haematin on Reduction to (Dr J E O'Hagan), 1808
  Pathway of Carbon-^{14} Incorporation from $NaH^{14}CO_3$ to, in Duck Blood incubated *in vitro* (A Breccia, A L Fantola, E Lazzarini and A Giustina), 1879
  Synthesis of, by Circulating Blood Cells (Peggy Clark and Dr R J Walsh), 1730
Haem and Porphyrin Biosynthesis Effect of Oxygen Tension on (J E Falk R J Porra and Ann Brown, and F Moss and Helen E Larminie), 1217
Haemagglutinin of Vaccinia Virus Effect of Concentrated Urea Solutions on the Infectivity and (Prof J F McCrea and Jean O'Loughlin), 1497
Haemagglutinins (Anti-A), from a Non-Leguminous Plant, *Hyptis suaveolens* Poit (Dr G W G Bird), 109
Haemagglutinins (Plant), (Lectins) A Method for Distinguishing between α- and β-Glycosides by the use of (Dr O Mäkela), 111
Haematin Decrease in Acid Strength of Propionate Side-Chains of, on Reduction to Haem (Dr J E O'Hagan), 1808
Haematin Systems in Cheese Fat Oxidation and (Tallowy Discoloration in Cheddar Cheese), (C G Rammell), 1296
Haematology (University of Cambridge Post-Graduate Medical School Symposium on), 1192
Haematopota insidiatrix Austen (Diptera, Tabanidae) in Southern Rhodesia (Dr Robert Barrass), 739
Haemocyanin on Starch Gel Electrophoretic Patterns Localization of (J R Whittaker), 193
Haemodynamics in Essential Hypertension (Dr J Brod, V Fencl, Z Hejl and J Jirka), 1643
Haemoglobin Nonhaem Iron in Erythrocytes as a Precursor for (Dr M Faber and Dr I Falbe-Hansen), 1043
  Properties and Inheritance of, by Asymmetric Recombination (Dr Harvey A Itano and Elizabeth Robinson), 1468
Haemoglobin with Unusual Alkaline-denaturation Properties in a Turkish-Cypriot Woman (Dr J E O'N Gillespie, Dr J C White, M J Ellis, Dr G H Beaven, W B Gratzer, Dr E M Shooter and R M E Parkhouse), 1876
Haemoglobin 'Bart's', a Foetal Haemoglobin without α-Chains (Abnormal Human Haemoglobins), (Dr J A Hunt and Dr H Lehmann), 872
Haemoglobin *E* Human—the Chemical Effect of Gene Mutation (Abnormal Human Haemoglobins), (Dr J A Hunt and Dr V M Ingram), 870
Haemoglobin *G* A Chemical Abnormality in (Dr Robert L Hill and Dr Herbert C Schwartz), 641
Haemoglobin *P* in a Family in the Belgian Congo (Dr Paulette Dherte, Dr H Lehmann and Dr J Vandepitte), 1133
Haemoglobin Pattern of the Cyclostome *Pertromyzon planeri* during the Course of Development (M Adinolfi, G Chieffi and M Siniscalco), 1325
Haemoglobin Synthesis Role of Stroma in—Experiments on Red Duck Cells *in vitro* (A Breccia, A L Fantola, E Lazzarini and A Giustina), 1878
Haemoglobin (Adult and Foetal Human) Serological Distinction of (G R E Naylor and M E Adair), 1854
Haemoglobin (Foetal) Estimation of Small Percentages of (Prof K Betke, H R Marti and I Schlicht), 1877
Haemoglobin (Foetal), in the Monkey (Dr G H Beaven and W B Gratzer), 1730
Haemoglobin (Foetal), without α-Chains Haemoglobin 'Bart's', a (Abnormal Human Haemoglobins), (Dr J A Hunt and Dr H Lehmann), 872
Haemoglobin ('Heated') Hydrolysis of (S Baar), 986
Haemoglobin (Hippopotamus) Paper Electrophoresis of (D H L Rollinson and G D Lomax), 1653

Haemoglobin (Human) The Heterogeneity of, *review* by Dr J A M Ager, 840
  A Terminal Peptide Sequence of (Dr J A Hunt and Dr V M Ingram), 640
Haemoglobin (Human Foetal) Heterogeneity of—Incidence of Foetal Variants in Singapore (Dr F Vella), 272
Haemoglobin (New Fast Abnormal), in Newborn Nigerians (Dr A E Boyo and R G Hendrickse), 997
Haemoglobin Synthesis in De-embryonated Chick Blastoderm 8-Azaguanine Inhibition of (B R A O'Brien), 376
Haemoglobin and Myoglobin Binding of Haem to Protein in (Dr J E Falk, Dr J N Phillips and Dr D D Perrin), 1651 , (Dr J E O'Hagan), 1652
Haemoglobin and Sensory Mechanisms, *review* by P A Merton, 1092
Haemoglobins Abnormal—a Symposium organized by the Council for International Organizations of Medical Sciences (edited by J H P Jonxis and J F Delafresnaye), *review* by Dr J A M Ager, 840
  Abnormal Human—Human Haemoglobin *E*—the Chemical Effect of Gene Mutation (Dr J A Hunt and Dr V M Ingram), 870 , Haemoglobin 'Bart's', a Foetal Haemoglobin without α-Chains (Dr J A Hunt and Dr H Lehmann), 872
Haemoglobins in Chum Salmon Two (K Hashimoto and Prof F Matsuura), 1418
Haemoglobins (Multiple), in Fish (Dr N Chandrasekhar), 1652
Haemolymph of *Petrobius maritimus* Leach Composition of the (Dr A P M Lockwood and Dr P C Croghan), 370
Haemolysis Accumulation of Dextran in Human Red Cells after (N V B Marsden and S G Östling), 723
Haemolytic Resistance Influence of X-Rays on the Activity of Carbonic Anhydrase in Erythrocytes and on their (A Lauwers, J Van Bavinchove and W Dierick), 111
Hagen, Prof P (Ono, S , and) Pyridoxal Phosphate, a Coenzyme for Histidine Decarboxylase, 1143
Hagene, Dr Philippe Distribution of Ascorbic Acid in the Leaves of some Plants, 284
Hagihara, Bunji, and others Oxidative and Phosphorylative Activities of Cytoplasmic Particles from Plant Tissue Cultures, 1491
Hagins, Dr W A , and Jennings, W H Energy Transfer with special reference to Biological Systems (Localization as Opposed to Migration of the Excitation in the Retinal Rods), 690
Hahn, G T , and others Atomic Mechanisms of Fracture (Tensile Fracture of Mild Steels), 325
Haida Carvers in Argillite (Prof Marius Barbeau), 409
Hailsham, Rt Hon Viscount The First Minister for Science, 1263
  Elected Rector of the University of Glasgow, 1915
Haines, M G Thermonuclear Research, 1017
Hair Sheep Light Regulation of Coat-Shedding in a Tropical Breed of (R B Symington), 1076
Hairs (Root) Cell-Wall Formation in (A B Wardrop), 996
Hairs (Sensory), in the Cristae of the Elasmobranch *Raja clavata* A Functional Interpretation of the Electron-Microscopic Structure of the, in Terms of Directional Sensitivity (Prof O Lowenstein and J Wersäll), 1807
Hais, Dr I M , und Macek, Dr K (herausgegeben von) Handbuch der Papierchromatographie, Band I, Grundlagen und Technik, *review* by Dr R Consden, 1436
Hajdukovic, S Biological Effects of Low Doses of Ionizing Radiations (Effects of X-Irradiation on the Blood Picture of Mammals), 1112
Hake, C L , and others Post-Exposure Analysis of Organic Compounds in the Blood by a Rapid Infra-red Technique, 192
Hakkinen, Dr H -M and Kulonen, E Increase in the γ-Aminobutyric Acid Content of Rat Brain after Ingestion of Ethanol, 726
Hala, Eduard, and others Vapour–Liquid Equilibrium (translated by G Standart), *review* by Dr R Sargent, 837
Halbwachs, Maurice The Psychology of Social Class (translated by Claire Delavenay), *review* by Prof T S Simey, 754
Halden (Norway) Reactor, 516
Hale, D K (Salmon, Dr J E , and) Ion Exchange, a Laboratory Manual, *review* by D Reichenberg, 1757
Hale, Dr L J Biological Laboratory Data, *review* by Prof R C McLean, 577
Haley, K B Appointed lecturer in engineering production at the University of Birmingham, 1026, 1362
Haley, Dr Thomas J , and others Prophylactic Effects of Amine Oxides in Radiation Injury in Mice, 198
Half-Life (Biological), of Radioiron in Man (R Oliver and Dr L G Lajtha), 1882
Halifax, Rt Hon the Earl of New Laboratories of the British Glass Industry Research Association opened by, 775
Hall, Dr A R From Axes to Atoms, *review*, 921
  Renaissance Anatomy, *review*, 1761
Hall, Dr A R , and others (edited by) A History of Technology, Vol 5, The Late Nineteenth Century, *review* by Dr Leonard Carmichael, B A 5
Hall, Prof E Raymond, and Kelson, Dr Keith R The Mammals of North America, *review* by Peter Crowcroft, 1524
Hall, Dr E T Awarded a supplementary grant of £600 by the Paul Instrument Fund Committee of the Royal Society, 507
Hall, Dr G G (Shull, Prof H , and) Atomic Units, 1559
Hall, Dr H T , and others Preparation of Diamond, 1094
Hall, Jr , Marshall, and others Some Aspects of Analysis and Probability, *review* by D G Kendall, 214
Hall, R S Appointed Research Fellow in physics in the University of Birmingham, 684
Hall, Victor E (edited by, in association with Frederick A Fuhrman and Arthur C Giese) Annual Review of Physiology, Vol 21, *review* by Prof D C Harrison, 838
Hallas, D G (Hewitt, Dr E J , and) Measurement of Inhibition by Azide in Biochemical Assay Systems involving Nitrite Estimation by Diazotization, 1485
Halleux, A , and others Coal Science (Chemical Reactions of Coal—Acetylation), 412
Halley Bay Geomagnetic Activity at, on Disturbed Days (J MacDowall), 1543
Hallimond, Dr A F Clay Minerals, 779
Halloysite Salt Desorption from (Prof G W Thomas), 1746
Halogen Atom Influence of the Size of the, on the Difference between Lattice Constants of Copper dipyridine dichloride and dibromide (Vladimir Kupcik and Slavomil Durovic), 1060
5- and 8- Halogeno- Dihydro- and Tetra-hydro-1-naphthoic Acids Plant Growth Activities of (Toshio Fujita, Sadao Imai, Koichi Koshimizu, Tetsuo Mitsui and Jiro Kato), 1415
Halogenoplatinates A Radiochemical Tracer Study of the Relative Stability of the (A J Poe and M S Vaidya), 1139
Halpern, —, and others Nuclear Forces and the Few-Nucleon Problem (Scattering of Nucleons by Light Nuclei at High Energy), 1113
Halpern, Dr B N , and others Promoting Effect of Urea on the *in vitro* Passive Sensitization of Isolated Plain Muscles with Precipitating Antibody, 1805
Haltner, Dr A J , and Zimm, Dr B H Rotational Friction Coefficients of Models of Tobacco Mosaic Virus and the Size of the Virus Particle, 265
Ham, Dr N S Second Australian Spectroscopy Conference, 1195
Ham, Dr N S , and Willis, Dr J B At the Second Australian Spectroscopy Conference (Infra-red and Raman Spectra of some Isothiocyanates), 1196
Hambly, Prof A N At the Second Australian Spectroscopy Conference (Infra-red, Raman and Microwave Work of 1958), 1196
Hambly, Prof A N , and Allpress, J G At the Second Australian Spectroscopy Conference (Infra-red Spectra can be used to follow some Solid State Reactions), 1196
Hambly, Prof A N , and Laby, R H At the Second Australian Spectroscopy Conference (Criteria for Allocating Displacements of *X*—H Bond Stretching Frequencies to the Formation of Hydrogen Bonds), 1196
Hamilton, Dr A G The Infra-Red Gas Analyser as a Means of Measuring the Carbon Dioxide Output of Individual Insects, 367
Hamilton, L D G , and others Disorganization of the Secondary Structure in Proteins exposed to Ionizing Radiations in the Solid State, 226
Hammack, E S , and others Coal Science (Chemical Reactions of Coal—Phenolic Hydroxyl in Vitrains), 412
Hammersley J M Fluctuation Phenomena and Stochastic Processes (Percolation Processes), 510
Hammerton, M A Mathematical Model for Perception and a Theoretical Confusion Function, 1668
Hammes, G G (Alberty, R A , and) Fast Chemical Reactions in Solution (Application of the Relaxation Method to Enzymatic Reactions), 1453
Hampden, John Distribution of Scientific Publications in Under-developed Countries, B A 22
Hampton, Dr W M The Development of Furnaces for Glass Melting (Fifth Chance Memorial Lecture of the Society of Chemical Industry), 772
Hanafusa, Hidesaburô, and others Transformations of Myxoma into Vaccinia or Ectromelia Virus in Tissue Culture, 1152
Hanafusa, Teruko, and others Transformations of Myxoma into Vaccinia or Ectromelia Virus in Tissue Culture, 1152
Hanaki, Akira, and others Incorporation of N-Methyl Carbon of Monoethylaminoazobenzene into Polar Dyes, 1460
Handicapped Children in Britain—their Problems and Education (compiled by W A Axford), (Library Association), 1777
Handling Radioactive Materials Glove Boxes and Shielded Cells for—a Record of the Proceedings of the Symposium on Glove Box Design and Operation held in the Cockcroft Hall, A E R E , Harwell, 1957 (edited by G N Walton), *review*, 1599
Hanessian, Jr , John, and Cormier, Leonard (edited by L V Berkner, in association with) Manual on Rockets and Satellites, *review*, 213
Hannah, Dr Margaret Awarded the Warner Medal of the Textile Institute, 26
Hanngren, Å , and others Fate of Injected Dextran Labelled with Tritium in Mice, 373
Hansel, C M Experimental Evidence for Extra-Sensory-Perception, 1515
Hansen, Dr Max Constitution of Binary Alloys, second edition, prepared with the co-operation of Dr Kurt Anderko, *review* by Dr F C Thompson, 1765
Hansen, Vagn Polar Front Survey (Biology—Carbon-14 Measurements and Chlorophyll Measurements in the North Atlantic and in the Greenland Sea), 1183
Hanson, A A , and Juska, F V A 'Progressive' Mutation induced in *Poa pratensis* L by Ionizing Radiation, 1000
Hanson, Dr J , and Lowy, Dr J Evidence for a Sliding Filament Contractile Mechanism in Tonic Smooth Muscles of Lamellibranch Molluscs, 286
Hanson, Dr J , and others Comparative Studies in Ultrastructure (Comparative Studies in the Contractile Structures of Striated and Smooth Muscles), 1446
Hanson, Prof Norwood Russell Patterns of Discovery, *review* by Gerd Buchdahl, 572
Hansson, E , and others Fate of Injected Dextran Labelled with Tritium in Mice, 373
Hanstrom, Bertil, and others (edited by) South African Animal Life—Results of the Lund University Expedition in 1950-1951, Vol 5, *review* 133
Hanuš, Dr V Isomerization to the Tropylium Ion induced by Electron Impact and its Significance, 1796
Haptoglobin The Behaviour of, during Routine Fractionation (Marion Steinbach and L Pejaudier), 362
Haptoglobin Groups in 406 French Blood Donors Frequencies of the (Dr J Moullec and Dr J M Fine), 196
Haptoglobin and Transferrin Variants in Bushmen and some other South African Peoples (Dr N A Barnicot, J P Garlick, Ronald Singer and Dr J S Weiner), 2042
Harada, Minoru, and others Change of Absorption Spectrum of Flavin Adenine Dinucleotide by its Binding with both D-Amino Acid Oxidase Apo-Protein and Benzoate, 1938
Harbourn, C L A Gas Chromatography (Quantitative Determinations), 1199
Harcombe, D , and others Ionization Phenomena in Gases, 1353
Hardened (Surface-) by Carbo-Nitriding Identification of the High-Temperature Constituent in Mild Steel (M A H Howes, G T F Jay, K Sachs and D Wilkinson), 1312

Hardiness (Winter-), of Insects Possible Rôle of Glycerol in the (P Dubach, D Pratt, Prof F Smith and C M Stewart), 288
Hardy, Sir Alister The Open Sea—its Natural History, Part 2, Fish and Fisheries, with Chapters on Whales, Turtles and Animals of the Sea Floor, *review* by S M Marshall, 666
Hargreaves, Dr W A *Obituary* by Dr Harold J Rodda, 92
Harington, Dr J S Contents of Cystine-Cysteine, Glutathione and Total Free Sulphydryl in Arsenic-resistant and Sensitive Strains of the Blue Tick, *Boophilus decoloratus*, 1739
Harker, H J, and others A Theory of the Abrasion of Solids such as Metals, 333
Harker, Dr Janet Animal Clocks (Complexity of Natural Internal Timing Mechanisms), 764
Harker, — Photography in the International Geophysical Year, 1032
Harkness, Dr M L R and Dr D R Flow Properties of Biological Systems (Changes in the Lower End of the Uterus and in the Cervix to allow of the Passage of the Foetus at Parturition), 1540
Harkness Fellowships of the Commonwealth Fund, 857
Harland, W B, and Bidgood, D E T Palaeomagnetism in some Norwegian Sparagmites and the Late Pre-Cambrian Ice Age, 1860
Harley, Dr J L A Source Book of Fungal Physiology, *review*, 85
Harling, J At the first Conference of the British Computer Society (Use of Computers for Operations Research), 946
Harlow, Harry F Origins of Love in Baby Rhesus Monkeys, 1203
Harmonic Generator A New Microwave (Dr K D Froome), 808
Harpaz, Dr I Needle Transmission of a New Maize Virus, B A 77
Harper, Dr F C Biomechanics (Forces exerted by the Human Foot in Walking), 513
Harper, Dr J L Appointed to the chair of agricultural botany in the University College of North Wales, Bangor, 503, work of, 503
Harrap, B S, and others Structure and Chemistry of Proteins (Soluble Wool Proteins), 1277
Harris, Bryan Appointed to a Tube Investments Research Fellowship for work in the physics and chemistry of solids, at the Cavendish Laboratory, Cambridge, 1535
Harris, Colin C Sedimentation Rates, Fluidization and Flow through Porous Media, 716
Harris, Prof E E Appointed acting head of the Department of Philosophy in the University of Edinburgh, 156
Harris, Dr F T C (Bearn, Dr J G, and) Relative Rates of Exchange of Potassium-42 by the Foetal Metanephros and Foetal Liver, 1959
Harris, G, and Davies, J W Nucleotide–Peptide Compounds of *Saccharomyces cerevisiae*, 788
Harris, G S Appointed a lecturer in chemistry at the University of Glasgow, 1915
Harris, Prof G W Distribution of Scientific Publications in Underdeveloped Countries, B A 23
Harris, Dr H (Cummins, Dr C S, and) Taxonomic Position of *Arthrobacter*, 831
Harris, Dr J Ieuan Structure of a Melanocyte-stimulating Hormone from the Human Pituitary Gland, 167
Harris, Sir Lionel Retirement as engineer-in-chief in the General Post Office, 1531, work of, 1531
Harris, Dr Leslie J Classics of Nutrition, *review*, 484
Harris, P F, and Kugler, J H Cells which Synthesize Deoxyribonucleic Acid in Guinea Pig Bone Marrow during Recovery from Whole-Body γ-Irradiation, 1883
Harrison, A (Winteringham, F P W, and) Mechanisms of Resistance of Adult Houseflies to the Insecticide Dieldrin, 608
Harrison, Dr B D, and Cadman, Dr C H Rôle of a Dagger Nematode (*Xiphinema* sp) in Outbreaks of Plant Diseases caused by Arabis Mosaic Virus, 1624
Harrison, Prof D C Progress in Physiology, *review*, 838
Harrison, E R Emission of Relatively High-Energy Ions from Low Voltage Arcs, 245
Harrison, Prof J Heslop Appointed to the chair of botany in the University of Birmingham, 684
Harrison, M J Awarded a Research Fellowship in physics in the University of Birmingham, 1688
Harrison, Prof R G (edited by) Studies on Fertility, including papers read at the Conference of the Society for the Study of Fertility, London, 1958, *review* by Dr T Mann, 1434
Harrison, Dr V G W New Techniques in Packaging, *review*, 1437
Harrod, Sir Roy The Prof—a Personal Memoir of Lord Cherwell *review* by Prof R V Jones, 1752
Hart, Julian Awarded a junior postgraduate agricultural research scholarship by An Foras Taluntais (the Agricultural Institute of Ireland), 1612
Hart, L I, and Andrews, E D Effect of Cobaltic Oxide Pellets on the Vitamin B_{12} Content of Ewes' Milk, 1242
Hartert, Dr H Flow Properties of Biological Systems (Rheology of the Hartert Technique for following the Process of Blood Coagulation by Measuring the Progressive Increase in Shear Modulus), 1540
Hartley, Brian S (Richmond, Virginia, and) A Two-Dimensional System for the Separation of Amino-Acids and Peptides on Paper, 1869
Hartley, Janet W, and others Antibody Status of Mice and Response of their Litters to Parotid Tumour Virus (Polyoma Virus), 1420
Hartley, R D Appointed Research Fellow in mining in the University of Birmingham, 684
Hartman, L, and Shorland, Dr F B Trans-Unsaturated Acids in the Depot Fats of Ruminants and Non-Ruminants, 2024
Hartman, Dr P Twinning of Crystals (Twin of Atacamite), 1911
Hartmann, Prof Max Elected a foreign associate of the United States National Academy of Sciences, 95
Hartshorne, Dr N H A Special Case of the Superposition of Crystal Plates between Crossed Polars and its Bearing on the Microscopy of Cellulosic Fibres, 179
Hartzell, jun, R, and others Effects of Deuterium Oxide on the Synthesis of *T5* and *T7* Bacteriophages, 1167
Harvard University (Staff of the Biological Laboratories of) Photochemical and Stereochemical Properties of Carotenoids at Low Temperatures —Photochemical Behaviour of Retinene (Dr Lawrence Jurkowitz), 614, *Cis-trans* Isomerism and Steric Hindrance (John N Loeb, Paul K Brown and Prof George Wald), 617, Discussion (Prof George Wald), 620
Harwell Reactor School Courses (Atomic Energy Research Establishment), 942
Haselden, Dr G G Appointed to the new chair of chemical engineering in the University of Leeds, 1106, work of, 1106
Low-Temperature Engineering, *review*, 1174
Haselgrove, C B, and Hoyle, F Structure and Age of the Stars, 1986
Haselgrove, D C Oil Pollution of the Sea (The Working of the Oil In Navigable Waters Act, 1955), 950
Hashimoto, K, and Matsuura, Prof F Two Haemoglobins in Chum Salmon, 1418
Haskell, Dr P T Appointed deputy director of the Anti-Locust Research Centre, London, 410, work of, 410
Annual Review of Entomology, *review*, 489
Haslewood, Prof G A D *Obituary* of Prof A O R Windaus, 150
Hassall, Prof C H, and Magnus, K E Monamycin, a New Antibiotic, 1223
Hasted, Dr J B Appointed reader in physics at University College, London, 1613
Hastings, Sir Charles The Life and Times of—Founder of the British Medical Association (Dr William H McMenemey), *review* by Dr W R Bett, 923
Hastrup, Dr J Awarded a scholarship by the Lady Tata Memorial Trust, for research on Leukaemia and allied Diseases, 507
Hat and Allied Feltmakers Research Association, British Annual Report (1957-58), 320
Hatch, M D and others Oxidation of Krebs Cycle Acids by Apple Tissue, 506
Hatching Control of, in the Prediapause Eggs of *Aedes* Mosquitoes (Dr J D Gillett), 1621
Hatfield Memorial Lecture (Academician G V Kurdjumov), 1450
Hatherton, Dr T (Coombs, Dr D S, and) Palaeomagnetic Studies of Cenozoic Volcanic Rocks in New Zealand, 883
Hatherton, Dr T, and Midwinter, G G Diurnal Variation of Aurora and Geomagnetic Disturbance at New Zealand Antarctic Stations, 889
Hattori, Dr S, and Noguchi, I Microbial Degradation of Rutin, 1145
Hattori, Tsutomu, and Furusaka, Choseki Chemical Activities of *E coli* adsorbed on a Resin, 'Dowex-I', 1566
Haughton, G, and Duthie, E S Activation of Staphylococcal-free Coagulase by Purified Human Prothrombin, 116
Hauser, Philip M, and Duncan, Otis Dudley (edited by) The Study of Population, *review* by Dr B Benjamin, 1521
Hausser, K H Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Havranek, M, and others Influence of DL-beta-Phenylserine on the Synthesis of Proteins in *Escherichia coli*, 1895
Hawarth, C W Appointed a lecturer in metallurgy at the University of Sheffield, 684
Hawker, Dr Lilian E British Parasitic Fungi, *review*, 1977
Hawker Siddeley Nuclear Power Co To supply a Neutron Source Thermal Reactor (*Nestor*) to the United Kingdom Atomic Energy Authority, 1533
Hawkins, A E (Jewell, P A, and) At the Conference of the Mammal Society of the British Isles (Normal Diet of the Water Shrew), 29
Hawkins, T H The Sea-Horse and its Relatives, *review*, 390
Anting, *review*, 665
Labour Turnover, 1110
Hawthorne, J N (Ellis, R B, and) 1-Glyceryl-2-*myo*-inositol Phosphate—Alternative Synthesis and Behaviour on Hydrolysis (Synthesis and Properties of 1-Glyceryl-2-*myo*-inositol Phosphate) 790
Hawtrey, A O (Silk, Dr M H, and) Possible Simplified Structure of Deoxyribonucleic Acid, 1484
Haxo, Dr F T, and Fork, D C Photoreactive Pigments in Flagellates—Photosynthetically Active Accessory Pigments of Cryptomonads, 1051
Hay (Douglas) Medal of the Institution of Mining Engineers awarded to A E Crook, 1845
Hayashi, T Plant Growth Regulation (Recent Work with the Gibberellins), 600
Hayden, P Estimation of Chain Fracture and Cross-Linking of Rubber by High-Energy Radiation, 1865
Hayes, M H B Appointed I C I Fellow in chemistry in the University of Birmingham, 1915
Hayward, D O Awarded a Senior Studentship by the Royal Commission for the Exhibition of 1851, 409
Hazards from Ionizing Radiations Advice concerning (Ministry of Housing and Local Government, Circular No 57/59), 1450
Hazards (Radiological), to Patients—Interim Report of the Committee (Ministry of Health and the Department of Health for Scotland), 162
Head of a Chick A Chimaeric Duck with the (Tamikazu Seno and Saburo Saito), B A 78
Heading, Dr J The Value of π and the Old Testament, 78
Appointed lecturer in applied mathematics at the University of Southampton, 595
Heads-Tails Statistics for Two Partially Distinguishable Coins (Gabriel Weinreich), 1825
Healing (Wound), and Tissue Repair (edited by W Bradford Patterson), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Health in Britain Industry and, 1456
Health of the School Child—Fifty Years of the School Health Service (Report of the Chief Medical Officer of the Ministry of Education for 1956 and 1957), 98
Health, Ministry of, and the Department of Health for Scotland Radiological Hazards to Patients—Interim Report of the Committee, 162
Health for Scotland, Department of (Ministry of Health and the) Radiological Hazards to Patients–Interim Report of the Committee, 162
Health, United States National Institutes of Ninth Annual Instrument Symposium and Research Equipment Exhibit, 26
Health, United States National Institutes of (Endocrinology Study Section) Free distribution of Pituitary Hormones, 1272
Health (Industrial), in the Potteries, 420
Health (Mental) Problems in Old Age (World Health Organization of the United Nations, Technical Report Series No 171), 1844
Health and Industry, 1023
Health Physics Radiation Safety and (J W Lucas), 329

Health Service, National Hospitals and the State—Hospital Organization and Administration under the, Sixth and Final Research Report (Creative Leadership in a State Service—a General Survey by Sir George Schuster), 1087, 1201
Health Service (School) The Health of the School Child—Fifty Years of the (Report of the Chief Medical Officer of the Ministry of Education for 1956 and 1957), 98
Healy, A J Introduction of Foreign Weeds into New Zealand, 1361
Hearing Effect of Jet Aircraft Noise on (Surg Lieut R R A Coles and J J Knight), 1803
Heart (Human) Histochemical Localization of Oxidase Activity in the Mitochondria of the (Dr M S Burstone), 476
Heart Sarcosomes Corticosterone Inhibition of Pyridine Nucleotide Oxidase from (P K Jensen), 451
Heart Sarcosomes (Guinea Pig) Reversal by Acetylcholine of the Inhibition by Thyroxine of Oxidative Phosphorylation in (Heitor Medina and Metry Bacila), 1066
Heastie, R Thermodynamics (Phase Changes in Condensed Systems), 1609
Heat Comparative Effects of, on Chromatography and Ultra-violet Absorption of Deoxyribo- or Ribo-Nucleic Acids (Dr Saul Kit), 36
Heat Inactivation of Rinderpest-infected Bovine Tissues (Dr G A Scott), 1948
Heat-Loss Mechanism involving the Habenular, Interpeduncular and Dorsal Tegmental Nuclei (B G Cragg), 1724
Heat Production (Thermoregulatory), in the Brain (Prof Sz Donhoffer, Gy Szegvari, I Jarai and M Farkas), 993
Heat Tolerance Exhibited by *Bos taurus* and *Bos indicus* Beef Cattle A Possible Explanation for Part of the Difference in (H P Ledger), 1405
Heat Treatment Electrical Resistivity Changes observed in a Semiconducting Diamond after (R E Mutch and Dr F A Raal), 1857
Heat and Moisture Probing Behaviour of *Aedes aegypti* (L) in Response to (L Burgess), 1968
'Heated' Haemoglobin Hydrolysis of (S Baar), 986
Heath, Prof O V S (Clark, Dr J E, and) Auxin and the Bulbing of Onions, 345
Heath, W G Structural Effects of Kinetic Heating (Some Factors affecting the Choice of Materials), 30
Heating Effects of, on X-Ray Diffraction by Carbons (Eitaro Matuyama), 544
Heating by Electron Bombardment (A Calverley), 690
Heating (Hydromagnetic) Upper Atmosphere Density Variations due to (Dr A J Dessler), 261
Heating (Kinetic) Structural Effects of (Royal Aeronautical Society Discussion on), 30
Heating (Plasma), by Current-Saturation (K A George), 1791
Heating Rates (Different) Number of Free Radicals in Coal during Carbonization at (J Smidt and Prof D W van Krevelen), 719
Heating and Ventilation (British Occupational Hygiene Society Conference on), 1987
Heavier Elements, *review* by Dr J K Dawson, 922
Heavily Sclerotized Whole Insects Sectioning Large (Prof W E Beckel), 1584
Heavy Water Growth of *Bacterium coli* and *Staphyloccus albus* in (Elizabeth van Horn and Dr G C Ware), 833
  Saliva-Serum Ratios of Deuterium Oxide after Administration of (Nan Taggart and Dr F E Hytten), 457
Hedberg, K O Origin and Dispersal of Flowering Plants (Modern Montane Distributions), 1200
Height-Frequency Curves Conversion of Ionospheric Virtual, to Electron Density-Height Profiles (Dr J O Thomas and M D Vickers), (Radio Research Board, Special Report No 28), 1024
Heilbron, Sir Ian *Obituary* by Dr A H Cook, 767 , *obituary* by Sir Robert Robinson, 768
Heilbronn, Prof H Elected president of the London Mathematical Society, 1533
Heilbrunn, Prof L V Flow Properties of Biological Systems (Methods for Measuring the Rheological Properties of Protoplasm), 1540
Heim, Prof Roger Opening Discourse at the Muséum National d'Histoire Naturelle's celebration of the anniversaries of the 'Precurseurs et Fondateurs de l'Évolutionnisme—Buffon, Lamarck, Darwin', 859
Henrich, Prof E Wm Mineralogy and Geology of Radioactive Raw Materials, *review* by Prof C F Davidson, 1262
Heinroth, Oskar and Katharina The Birds (English edition prepared by Michael Cullen), *review*, 1439
Heiser, P (Sandford, B P, and) Colour Photography of the Aurora, 540
Heisler, L H A Relation between Giant Travelling Disturbances and Sporadic E Ionization 1788
Hejl, Z, and others Haemodynamics in Essential Hypertension, 1643
Hela, Prof I Polar Front Survey (Hydrography—Finnish work in the Barents Sea), 1181
HeLa Cells Discarded Blood Bank Blood as a Source of Protein for Cultivation of (Billy R Blakey and Prof George E Gifford), 1158
HeLa Cells (Multiplying) Deoxyribonucleic Acid Formation in (C L Smith, A A Newton and P Wildy), 107
HeLa Tumour Tissue in Culture Production of Serum Albumin and of Globulins by Chick Mesenchymal Tissue and by (Y Abdel-Samie Prof E Broda, G Kellner and W Zischka), 361, *erratum*, 943
Heligoland The New Marine Biological Station on (Dr J N Carruthers) 400
Helium Film Measurement of the Thickness of the (Prof L C Jackson) 954
Hellbaum, Arthur A, and others Effect of Prolonged Thyroid Administration on Aged Male Rats, 1149
Hellemans, A Elected an honorary member of the Institution of Mining Engineers, 1845
Heller, Frank A (edited by) New Developments in Training—Five Studies in the Efficient Communication of Skills, 421
Heller, Prof H (Pickering, B T, and) Active Principles of the Neurohypophysis of Cold-blooded Vertebrates—Chromatographic and Biological Characteristics of Fish and Frog Neurohypophysial Extracts, 1463
Hellman, Bo Actual Distribution of the Number and Volume of the Islets of Langerhans in Different Size Classes in Non-diabetic Humans of Varying Ages, 1498
Hellmers, Henry, and Sundahl, William P Response of *Sequoia sepervirens* (D Don) Endl and *Pseudotsuga menziesii* (Mirb) Franco Seedlings to Temperature, 1247
Help for the Arts (Calouste Gulbenkian Foundation), 699
Helsby, R (Pratt, M W T, and) Ultrasonically Dispersed Sodium, 1694
Hemihydrate (Calcium Sulphate) Transition of, to Insoluble Anhydrite (Chikara Mitsuki and Masayoshi Kita), 1481
Hemileucine Moth Central Control of Interactions between Behaviour Patterns in a (Dr A D Blest), 1164
Hemingway, Prof A Artificial Organs—Biological Applications (Presidential Address to Section I (Physiology and Biochemistry) of the British Association for the Advancement of Science), B A 45
Hems, D A, and others Fusion Frequency and Light Quantity, 1873
Henbest, Prof H B Oxidation of Organic Compounds (Oxidation of Trialkylamines), 327
Henderson, Dr J N Presidential Address to the Eleventh Annual Convention of the Canadian Veterinary Medical Association, 695
Hendley, D A (Powell, C and) Awarded the Clerk Maxwell Premium of the British Institution of Radio Engineers, 857
Hendlin, Dr D, and Demain, Dr A L An Absolute Requirement for 'Iron Transport Factors' by *Microbacterium lacticum* 8181, 1894
Hendrickse, R G (Boyo, Dr A E, and) New Fast Abnormal Haemoglobin in Newborn Nigerians, 997
Hendrickson, Prof J R Appointed to the chair of zoology in the University of Malaya in Kuala Lumpur, 307 , work of, 307
Hendy, Sir Philip Museums and Finance, 598
Henisch, Dr H K Semiconducting Silicon Carbide, 158
Henley, Dr Keith S, and others Some Enzymatic Properties of Suspensions of Parenchymatous Liver Cells, 1400
Henty, C J Awarded a Nature Conservancy Research Studentship for postgraduate training in ecology (zoology), 156
Heparin and Cellular Calcium (D Thomason and R Schofield), 1712
Hepatoma (Rat Sarcoma and) An Attempt to produce Malignant Change with Deoxyribonucleic Acid from (Dr J G Bearn), 824
Heptapeptide (Protected) Synthesis of a, related to the Histidine Analogue of Hypertensin II (Dr Dimitrios Theodoropoulos), 1634
Herbage Intake (Internal Fat, 'Fill', and the), of Grazing Cattle A Relationship between Weight of (J C Tayler), 2021
Herbert D C Strength of a Grooved Stud, 897
Herbert, I M (Ainger, F W, and) Special Ceramics (Preparation of Phosphorus-Nitrogen Compounds as Non-porous Solids), 1116
Herbicides Effects of Substituted Phenoxy-Compounds and other Translocated, on the Rhizome of Bracken (Dr Elsie Conway and J A Forrest), 1416
Hereditary Absence of the Spleen in the Mouse (A G Searle), 1419
Herlach, F Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Herley, P J, and Prout, E G Thermal Decomposition of Irradiated Lead Oxalate, 445
Hermann, F Polar Front Survey—Hydrography (Shetland–Faroe–Iceland Region), 1182 , (Danish Observations in the North Atlantic), 1182
Hermit Crab (*Eupagurus bernhardus*) The Sea Anemone (*Calliactis parasitica*) and the (Dr D M Ross), 1161
Herndon, John F, and others Effect of Ethylenediamine Tetra-acetate on Vitamin B_{12} Absorption in the Rat, 1948
Herpes Simplex Virus Purification of, by Chromatography of Calcium Phosphate (Janice Taverne and Peter Wildy), 1655
Herr, W Radioactivation Analysis (Uses of Activation Analysis in Geochemistry), 951
Herrinck, Dr P Prediction of Sunspot Numbers until the End of the Present Cycle, 51
  Tides in the F_2 Ionospheric Layer, 1055
Herring, G J New Techniques in the Analysis of Noise and Vibration (An Analogue-to-Digital Converter), 415
Hertz (Heinrich) Premium of the British Institution of Radio Engineers awarded to K Foster, 857
Herz, Dr A J, and others Radiation Observations with Satellite 1958δ over Australia, 391
Herzka, A, and Pickthall, J Pressurized Packaging (Aerosols), *review* by Dr V G W Harrison, 1437
Hesketh, Dr V Crystal Physics, 596
Heslop-Harrison, Prof J Genetics and the Origin of Species, 588
Hess, Prof George P (Marini, Mario A, and) Reactivity and Interrelationship of Intermediates in the Hydrolysis of *p*-Nitrophenyl Acetate Catalysed by Chymotrypsin, 113
Hessler, V P, and Wescott, E M Correlation between Earth-Current and Geomagnetic Disturbance, 627
Heterocyclic Chemistry (Prof Adrien Albert), *review* by Dr F G Mann, 216
Heterocyclic Chemistry, *review* by Dr F G Mann, 1758
Heterocyclic Compounds (edited by Dr E H Rodd), (Chemistry of Carbon Compounds, Vol 4, Part B), *review* by Dr F G Mann, 1758
  The Chemistry of, Vol 13, *s*-Triazines and Derivatives (edited by Edwin M Smolin and Lorence Rapoport), *review* by Dr F G Mann, 1758
Heterocyclic Nitrogen Compounds Six-Membered, with Three Condensed Rings (C F H Allen, in collaboration with G M Badger, Brice Graham, G A Reynolds, James H Richmond, John R Thirtle, J A Van Allen and C V Wilson), *review* by Dr F G Mann, 216
Heterodera trifolii Goffart 1932 Giant Eggs of the Clover Cyst Nematode (Roland H Mulvey), 1662
Heterogeneity of Human Foetal Haemoglobin—Incidence of Foetal Variants in Singapore (Dr F Vella), 272
Heterogeneity of Human Haemoglobin, *review* by Dr J A M Ager, 840
Heterogeneity (Electrophoretic), of Trypsin (J C Perrone, L V Disitzer and A Iachan), 1225
Heterogeneous Catalysis, *review* by Dr F S Stone, 1974
Heterosis and the Genetics of Complex Characters (Watkin Williams), 527
Heuchamps, C, and others Coal Science (Energy of Activation of the Combustion of Graphite), 414
Hevea in Malaya Maladies of (Roger N Hilton), *review* by R W G Dennis, 1976
Hevea Latex Ultracentrifugation and Staining of (G F J Moir), 1626
Hewitt, Edwin, and others Some Aspects of Analysis and Probability, *review* by D G Kendall, 214

Hewitt, Dr E J , and Hallas, D G Measurement of Inhibition by Azide in Biochemical Assay Systems involving Nitrite Estimation by Diazotization, 1485
Hexagonal Boron Nitride Transformation of a Cubic Boron Nitride to a Graphitic Form of (H Judith Milledge, E Nave and F H Weller), 715
n-Hexane (Liquid) Conduction Currents in, under Microsecond Pulse Conditions (A Harry Sharbaugh and P Keith Watson), 2006
Hexokinase (Liver) Inhibition of by Dehydroascorbic Acid and Alloxan (Dr S K Bhattacharya), 1638
Hey, G L , and Marshall, K The Control of Pests and Diseases in Agricultural and Horticultural Crops, *review* by F C Bawden, 1258
Hey, Dr J S Promoted to Deputy Chief Scientific Officer in the Scientific Civil Service, 858 , work of, 858
Heylen, A E D Ionization Phenomena in Gases (Recent Measurements on the Growth of Pre-breakdown Ionization Currents for several Organic Vapours), 1354
Heyrovsky, Prof J Awarded the first Polarographic Society Medal, 772
  Awarded the Nobel Prize for Chemistry for 1959, 1271 , work of, 1271
Heyting, Prof A (edited by) Constructivity in Mathematics—Proceedings of the Colloquium held at Amsterdam 1957, *review* by Dr Hao Wang, 1435
Heywood, Dr H Transactions of the International Conference on the Use of Solar Energy, *review*, 217
Hibernating Bats Endogenous Rhythms of Body Temperature in (Prof Michael Menaker), 1251
Hickinbottom, Dr W J , and Garwood, Dr R F Oxidation of Organic Compounds, 326
Hicklin, Dr J A Salicylate and Potassium Fluxes of Rat Diaphragm, 2029
Hiding Animals in (D G Lambert), 1535
Hieger, Dr I The Imperial Cancer Research Fund, 783
Higgins, Dr Charles C , and others Statement on Biological and Chemical Warfare, 1018
Higgins, G M C , and others Incorporation of DL-[2-^{14}C] Mevalonic Acid Lactone into Polyisoprene, 268, *erratum*, 772
Higgins, H G (Nissan, Prof Alfred H , and) A Molecular Approach to the Problem of Viscoelasticity, 1477
High-Altitude Nuclear Explosions Geophysical Effects of (W A Feibelman), 442
  Magnetic Effects resulting from Two (J A Lawrie, V B Gerard and P J Gill), B A 34
High-Altitude Research British Contribution to, 1776
High Commissioner in New Delhi (United Kingdom) Appointment of Dr H R Ambler as scientific adviser to the, 1448
High-Energy Ions (Relatively) Emission of, from Low-Voltage Arcs (E R Harrison), 245
High-Energy Radiation Estimation of Chain Fracture and Cross-Linking of Rubber by (P Hayden), 1865
High Frequency (Very) Radio Signals at Ionospheric Heights Refraction of (S Weisbrod and L Colin), 119
High Ganglion-blocking Activity Congeners of Pempidine with (L Bretherick, G E Lee, E Lunt, W R Wragg and N D Edge), 1707
High-Level β-Amino-*iso*butyric Acid Excretors in Micronesians High Prevalence of (Dr B S Blumberg and Dr S M Gartler), 1990
High Levels of Phosphorus and Die-Back in Yellow Lupins (R G Warren and B Benzian), 1588
High Levels of Survival Mutation of Bacteria at, by Ethyl Methane Sulphonate (Anthony Loveless and Sheila Howarth), 1780
High Molecular Compounds (published in the Russian language by the Academy of Sciences of the U S S R), 410
High Molecular Weight Ribonucleic Acids from the Nuclei of Calf Thymus (Dr Ping-yao Cheng), 190
High Polymer Chemistry New Techniques in (Bradford Institute of Technology Course in), 1845
High-Pressure Oxygen and Radiotherapy, 94
High Prevalence of High-Level β-Amino-*iso*butyric Acid Excretors in Micronesians (Dr B S Blumberg and Dr S M Gartler), 1990
High-Purity Aluminium Analysis for Magnesium in (C A Youngdahl and F E DeBoer), 54
High-Resolution Fibre Optics using Sub-Micron Multiple Fibres (Dr N S Kapany), 881
High Reynolds Number (Very) A Spectrum of Turbulence at (H L Grant, A Moilliet and Prof R W Stewart), 808
High Speed Computing (Dr S H Hollingdale), *review* by E M Deeley, 1832
High-Temperature Constituent in Mild Steel Surface-Hardened by Carbo-Nitriding Identification of the (M A H Howes, G T F Jay, K Sachs and D Wilkinson), 1312
High-Temperature Gas Jet Blunt-Nosed Bodies in a (F R Sedlund and Prof C C Chang), 812
High-Temperature (Low- and), Strains of *Chlorella* Tabular Comparative Data for the (Dr Constantine Sorokin), 613
High Temperatures Extremely (Electronics Research Directorate of the United States Air Force Cambridge Research Center Conference on, Boston, 1958), (edited by Dr Heinz Fischer and Lawrence C Mansur), *review* by Dr T E Allibone, 83
High-Voltage Paper Electrophoresis of Aliphatic Amines and related Compounds (Dr D Gross), 1633
High-Voltage Paper Electrophoresis (Two-Dimensional), of Amino- and other Organic Acids (Dr D Gross), 1298
High and Low Water Content Free Radicals in X-Rayed Seeds of, as Measured by Electron Spin Resonance (Dr W Klingmuller, Dr G R Lane, M C Saxena and Dr D J E Ingram), 464
Higher Education in East Africa Report of the Working Party on (1958), 243
  White Paper on, 243
  Work on the New Technical Institute, 1611
Higher Education in Nigeria, International Commission on Inaugural Meeting, 152
Higher Education in the U S S R , 504
Higher Education (Secondary and), in Britain, 1671
Higher Hydrogen Peroxide, H_2O_4? A (Dr J G Marshall and Dr P V Rutledge), 2012
Higher Plants A New Technique for Isolating and Cloning Cells of (Ludwig Bergmann), 648
Higher Proprioceptive Centres Possible Role of, in the Perception of Visual Space and in the Control of Motor Behaviour (Dr B Gurevitch), 1219
Higher Terpenoids (P de Mayo), (The Chemistry of Natural Products, Vol 3), *review* by Prof A J Birch, 754
Highlands (Scottish) Conservation in the (Scottish Branch of the Institute of Biology Symposium on), 1529
Highly Polymerized Spleen Deoxyribonucleic Acid labelled with Phosphorus-32 Injected Intraperitoneally into Rats Fate of the (Tamara A Hudnik-Plevnik, Vladimir R Glišin and Marta M Simić), 1818
Highly Purified Carbohydrate-free Johnin Protein Preparation of a (E Annau), 1642
Highly Purified Sample of the Urinary Gonadotrophin Preparation of a (Roland Bourrillon, René Got and René Marcy), 983
Highway and Traffic Engineering at Birmingham, 939
Higuchi Masataka, and Uemura, Prof Teijiro Release of Nucleotides from Yeast Cells, 1381
Hildebrandt Prof A C, and others Oxidative and Phosphorylative Activities of Cytoplasmic Particles from Plant Tissue Cultures, 1491
Hilger and Watts, Ltd Amalgamation of the Infra-Red Development Co , Ltd , with, 1273
Hill, Prof A V Origins and Methods of the Sciences, *review*, 4
Hill, Charles H , and Garren, Henry W Differentiation between a Growth-Promoting Factor and a Tumour-Susceptibility Factor in Eggs, 824
Hill, C R (Mayneord, Prof W V , and) Spectroscopic Identification of Alpha-Emitting Nuclides in Biological Material, 667
Hill, Dr D W Report on the research work of the Shirley Institute, 1846
Hill, D W , and others 'Supercarbia' in the Anaesthetized Dog, 1071
Hill, Dr George J , and others Maintenance of Parathyroid Tissue Fragments on Agar Substrates, 1734
Hill, H J (edited by F X Gassner, in association with Rue Jensen and) Proceedings of the Third Symposium on Reproduction and Infertility, Colorado State University, *review* by Dr T Mann, 1434
Hill, J E Fauna of Netherlands New Guinea, *review*, 1261
Hill, Hon Lister The Structure of Science, B A 6
Hill, jun , Rolla B , and others Unimpaired Mitosis in Cells with Modified Deoxyribonucleic Acid, 1429
Hill, R J , and Jacobs, P W M Field Effects on Chemisorbed Films in Electron Emission Microscopy, 895
Hill, Dr Robert L , and Schwartz, Dr Herbert C A Chemical Abnormality in Haemoglobin *G*, 641
Hill, W H Promoted to Deputy Chief Scientific Officer and appointed deputy director of Air Armament Research in the Ministry of Aviation, 1448, 1775 , work of, 1775
Hill Reaction Relationship between Photophosphorylation and the (Dr H E Davenport), 524
Hillas, A M , and Cranshaw, T E A Comparison of the Charges of the Electron, Proton and Neutron, 892
Hillas, A N Appointed to a lectureship in the Department of Physics in the University of Leeds, 1108
Hiller, Jr , Prof L A , and Isaacson, Leonard M Experimental Music—Composition with an Electronic Computer, *review* by Prof E G Richardson, 1754
Hills, G J , and others A Suspected Virus Disease of the Citrus Red Mite *Panonychus citri* (McG), 70
Hills, Prof T L The St Lawrence Seaway and Power Projects—Geographical Background, B A 49
Hills (Malvern) Preservation of the, 1272
Hilson, Dr G R Appointed reader in bacteriology at St George's Hospital Medical School, London, 322
Hilton, Roger N Maladies of Hevea in Malaya, *review* by R W G Dennis, 1976
Himmelfarb, Dr Gertrude Darwin and the Darwinian Revolution, *review* by Sir Gavin de Beer, 385
Hindmarsh, W R Collision Effects in Atomic Spectra, 155
Hindrance (Steric) *Cis-trans* Isomerism and (Photochemical and Stereochemical Properties of Carotenoids at Low Temperatures), (John N Loeb, Paul K Brown and Prof George Wald), 617
Hindwood, K A , and McGill, A R The Birds of Sydney (County of Cumberland), New South Wales, *review* by Dr A J Marshall, 841
Hines, Marion, and others Effects of Irradiation of Nerve on Muscular Response, 734
Hinke, Dr J A M Glass Micro-Electrodes for Measuring Intracellular Activities of Sodium and Potassium, 1257
  Alkali Ion Determinations by means of Glass Electrodes (Application of Glass Electrodes responsive to Alkali Ions in Experimental Biology and Medicine), 1618
Hinshelwood Sir Cyril Re-elected president of the Royal Society, 1610
  The Internal and the External Worlds (Anniversary Address to the Royal Society), 1834
Hinton, Dr H E Plastron Respiration in the Eggs of *Drosophila* and other Flies, 280
Hippocampus of the Rabbit A Specific Response in the, to Olfactory Stimulation (B G Cragg), 1697
Hippopotamus Haemoglobin Paper Electrophoresis of (D H L Rollinson and G D Lomax), 1653
Hips (Rose) The Organic Acids in (Dr G A D Jackson and S E Y Barakat), 1953
  Presence in, of Substances Inhibiting the Oxidation of Ascorbic Acid (Dr G A D Jackson and R B Wood), 902
Hird, F J R and others Structure and Chemistry of Proteins (Rôle of Thiols in Disulphide Interchange Reactions), 1277
Hirst, Prof E L Elected president for 1959-60 of the Royal Society of Edinburgh, 1192
Histamine Release of, from Rat Mast Cells by Blood treated with Dextran (Dr G T Archer), 1151
Histamine (Urinary), in Adrenalectomized Rats Sodium Chloride Intake and (Dr T Bjuro and Dr H Westling), 1241
Histamine Sensitizing Factor Formation of the Toxoid of, in *Bordetella pertussis* (Prof Toshitaka Matsui and Yoshio Kuwajima), 199
Histidine Analogue of Hypertensin II Synthesis of a Protected Heptapeptide related to the (Dr Dimitrios Theodoropoulos), 1634
Histidine–Copper (II) Complexes (Dr D D Perrin), 1868
Histidine Decarboxylase Pyridoxal Phosphate, a Coenzyme for (S Ono and Prof P Hagen), 1143
Histiocytes A Method for *in vitro* Investigation of the Colloid-storing Function of (Prof N Jancso, Aurelia Jancso-Gabor and J Balassy), 1070

Histochemical Localization of Oxidase Activity in the Mitochondria of the Human Heart (Dr M S Burstone), 476
Histochemical Study of Monoamine Oxidase in the Developing Rat Brain (Nobuo Shimizu and Nogaaki Morikawa), 650
Histochemical Technique (Dr W G Bruce Casselman), *review* by Dr T Kerr, 752
Histochemical Use of the Cyanocarbon Organic Compounds (Prof John F Lhotka), 1153
Histological Localization of Fluorescent Thyroid-stimulating Hormone in Rat Tissues (Dr E E Mancini, O Vilar, J M Dellacha, A Gimeno and A Castro), 1733
Histological Localization of Peroxidase (D S Van Fleet), 506
Histology (Comparative) Textbook of (Dr Warren Andrews), *review* by Dr T Kerr, 752
Historical Geology Outline of (A K Wells), fourth edition, *review*, 1093
History of Chemistry Chymia—Annual Studies in the, Vol 5 (edited by Henry M Leicester), *review* by Prof J R Partington, 1900
History of Cosmology, *review* by Prof E J Dijksterhuis, 836
History of Embryology (Dr Joseph Needham), second edition, *review* by Sir Julian Huxley, 1176
History of the Gramophone From Tinfoil to Tape—the (John Cain), 1535
History of Iron and Steel in China, *review* by Prof F C Thompson, 1830
History of Magic and Experimental Science (Prof Lynn Thorndike), Vols 7 and 8, The Seventeenth Century, *review* by Dr V A Eyles, 1899
History of Nutrition (Prof Elmer Verner McCollum), edited by H Bentley Glass, *review* by Dr Leslie J Harris, 484
History of Technology (edited by Dr Charles Singer, Dr E J Holmyard, A R Hall and Trevor I Williams), Vol 5, The Late Nineteenth Century, *review* by Dr Leonard Carmichael, B A 5
History of Technology and Engineering Man the Maker—a (Prof R J Forbes), *review* by Dr A R Hall, 921
History of Western Technology (Friedrich Klemm), translated from the German by Dorothea Waley Singer, *review* by K R Gilbert, 1601
History of Western Thought, *review* by Gerd Buchdahl 1829
History (Medical) Egypt and Greece in, *review* by Dr Douglas Guthrie, 662
History and Methods of the Sciences Studies in the (Prof Arthur David Ritchie), *review* by Prof A V Hill, 4
History and Philosophy of Science (L W H Hull), *review* by Dr H D Anthony, 131
Hlebarova, M, and others Agar Electrophoresis of Normal Soluble Proteins in Guinea Pig Liver, B A 64
Ho Prof Robert Appointed to the chair of geography in the University of Malaya in Kuala Lumpur, 307, work of, 307
Hoar, Prof W S (Ali, Dr M A, and) Retinal Responses of Pink Salmon associated with its Downstream Migration, 106
Hobbiger, Dr F Appointed to the University of London readership in pharmacology at Middlesex Hospital Medical School, 595
Hobday, Dr G I Boots' New Biological Research Laboratories, 1274
Hobhouse, Sir John Museums and Finance, 598
Hochstrasser, G Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Hockenhull, Dr D J D (edited by) Progress in Industrial Microbiology, Vol 1, *review* by Dr N Blakebrough, 1598
Hodge, Sir William Elected a foreign associate of the United States National Academy of Sciences, 95
  Presented with the De Morgan Medal of the London Mathematical Society, 1533
Hodgkin, Prof A L Appointed a member of the Medical Research Council, 772
Hoffman, J D Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 157
Hoffmann, Adolphe Faune de France, Vol 62, Coleoptères Curculionides, triosième partie, *review* by R T Thompson, 573
Hofstee, Dr B H J Non-Inverted versus Inverted Plots in Enzyme Kinetics, 1296
Hogben, Prof Lancelot At the Annual Conference of the Library Association (Past, Present and Future of the Printed Page), 1455
Hogberg, L, and others Ionization Phenomena in Gases (Apparatus for the Electrode-less Generation and Acceleration of Plasma Rings), 1357
Hogg, W R Appointed a lecturer in experimental and theoretical physics at the University of Glasgow, 1915
Hohn, Prof E O Prolactin in the Cowbird's Pituitary in relation to Avian Brood Parasitism, 2030
Hohnck, Dr W Polar Front Survey (Biology—Quantity and Types of Fungi in the Sea and on the Sea Bed), 1184
Hokin, Dr Lowell E, and Hokin, Mable R Evidence for Phosphatidic Acid as the Sodium Carrier, 1068
Hokin, Mabel R (Hokin, Dr Lowell E, and) Evidence for Phosphatidic Acid as the Sodium Carrier, 1068
Holden, H W (Robb, J C, and) Coal Science (Spectroscopy of Coals—Volatile Products either Volatilized or Liberated by Pyrolysis when Coal was Heated in the Ion Source), 413
Holdridge, D A Clay Minerals (Use of Thermal Expansion Measurements in Indicating the Mineralogy of Clays), 780, (Thermal Expansion Measurements for Studying Phase Changes on Firing), 780
Holdsworth, M Female-sterile Flowers in *Fuchsia*, 1024
Holland, C H, and others A Revised Classification of the Ludlovian Succession at Ludlow, 1037
Holland, L Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Rate of Evaporation from Pendant Drops Bombarded with Electrons—Application to 'Evaporion' Pumps), 692
Holliday, Dr A K Appointed to a senior lectureship in inorganic and physical chemistry in the University of Liverpool, 410
Hollingdale, Dr S H High Speed Computing, *review* by E M Deeley, 1832
Hollingsworth, Dr M A Appointed lecturer in mechanical engineering at the University of Bristol, 1613
Hollingworth, Prof S E The Great Lakes, *review*, 665
Holloway, Dr B W, and Monk, Marilyn Transduction in *seudomonas aeruginosa*, 1426
Holmes, Dr R L A Nucleus of Nerve Cells in the Ferret Pituitary Gland, 1819
Holmyard, Dr E J *Obituary* by Prof J R Partington, 1360
Holmyard, Dr E J, and others (edited by) A History of Technology, Vol 5, The Late Nineteenth Century *review* by Dr Leonard Carmichael, B A 5
Holser, Dr W T Twinning of Crystals (Relations of Symmetry and Structure at the Boundary Plane of a Twin), 1911
Holt, O, and others The *D* Region of the Ionosphere, 973
Holweck Lecture of the Physical Society (Prof A Abragam), 954
Home Counties (London and) Regional Advisory Council for Technological Education Tenth Annual Report, 94
Home Universities Conference 1959, 1613
Homer, R F, and Tomlinson, T E Redox Properties of some Dipyridyl Quaternary Salts, 2012
Homograft Reaction Dietary Factors in the (Dr A S Parkes), 699
Homografts (Cartilage), in Papain-injected Rabbits (M B L Craigmyle), 1243
Homografts (Skin) Tolerance to, of Adult Mice after Parabiosis (Dr B A Rubin), 205
Homografts (Skin), in Parabiotic Mice (Anna Skowron-Cendrzak and Barbara Konieczna-Marczynska), 1590
Honegger Dr Conrad G, and Honegger, Ruth Occurrence and Quantitative Determination of 2-Dimethylaminoethanol in Animal Tissue Extracts, 550, *erratum*, 1986
Honegger, Ruth (Honegger, Dr Conrad G, and) Occurrence and Quantitative Determination of 2-Dimethylaminoethanol in Animal Tissue Extracts, 550, *erratum*, 1986
Honey Bees (*Apis mellifica* L) Isolation of 24-Methylene-cholesterol from (Dr M Barbier, Prof T Reichstein, Dr O Schindler and Prof E Lederer), 732
Honeycombe, R W K, and Beevers, C J Atomic Mechanisms of Fracture (Suppression of Necking, even in Single Crystals of a Face-centred Cubic Material), 325
Hook, O, and Southern, H N At the Conference of the Mammal Society of the British Isles (Erosion caused by Hippopatami in Uganda), 30
Hooke (Robert), and Boyle's Air Pump (Dr H D Turner), 395
Hopkins, B J, and others Ionization Phenomena in Gases (State of the Cathode on Growth Times and Sparking Potentials in Hydrogen), 1354
Hopkins, Dr H G Promoted to Deputy Chief Scientific Officer in the Scientific Civil Service, 858, work of, 858
Hopkinson, B E, and Carroll, K G Chromium Distribution around Grain Boundary Carbides found in Austenitic Stainless Steel, 1479
Hopkinson, Dr R G, and Longmore, J Awarded the Leon Gaster Memorial Premium for 1959 of the Illuminating Engineering Society, 1272
Hops (Seedless) Production of, by Interspecific Pollination (Prof Edward L Davis), 1336
Horden, F W A (Burley, R W, and) Experiments on Wool from Copper-deficient Sheep, 1725
Horigan, Thomas J (Scheuer, Prof Paul J, and) A New Carbonyl Compound from *Piper methysticum* Forst, 979
Horiguchi, Masaaki, and Kandatsu, Makoto Isolation of 2-Aminoethane Phosphonic Acid from Rumen Protozoa, 901
Horikawa, Dr Masakatsu, and Kuroda, Dr Yukiaki *In vitro* Cultivation of Blood Cells of *Drosophila melanogaster* In a Synthetic Medium, 2017
Horlock, Prof J H Research in Gas Dynamics, *review*, 1173
Hormonal Control of Selective Feeding in Female *Calliphora erythrocephala* Meig (J Strangways-Dixon), 2040
Hormonal Principle Natriferin, a New, in the Neurohypophysis of certain Vertebrates (J Maetz, F Morel and B Lahlouh), 1236
Hormone (Fluorescent Thyroid-stimulating), in Rat Tissues Histological Localization of (Dr E E Mancini, O Vilar, J M Dellacha, A Gimeno and A Castro), 1733
Hormone (Melanocyte-stimulating), from the Human Pituitary Gland Structure of a (Dr J Ieuan Harris), 167
Hormone Action Mechanism of (Prof Aaron B Lerner), 674
Hormone Content of the Thymus in the Rat Effect of Adrenalectomy on the (Dr J Comsa), 279
Hormone Effects of Early Distribution and Disappearance from the Blood of Promethium-147 in Rats (Dr Bergene Kawin), 1816
Hormone Extracts (Juvenile), of Insects Prothoracic Gland Stimulation by (Dr Lawrence I Gilbert and Dr Howard A Schneiderman), 171
Hormones in Crustaceans, *review* by Prof J H Welsh, 1761
Hormones (Pituitary) Free Distribution of (Endocrinology Study Section of the United States National Institutes of Health), 1272
Horn, Gabriel, and Blundell, John Evoked Potentials in Visual Cortex of the Unanaesthetized Cat, 173
Horne, Dr J British Universities Film Council, 330
Hornstein, Irwin and others Gas Chromatographic Separation of Long-chain Fatty Acid Methyl Esters on Polyvinyl Acetate, 1710
Hornworm (Tobacco) *Protoparce sexta* (Johan) and the Colorado Potato Beetle, *Leptinotarsa decemlineata* (Say) Common Attractant for the (Dr Robert T Yamamoto and Prof G Fraenkel), 206
Horowitz, Dr Jack, and Chargaff, Prof Erwin Massive Incorporation of 5-Fluorouracil into a Bacterial Ribonucleic Acid, 1213
Horse The Mongolian Wild (*Equus przewalskii*), (A G Bannikov), 1024, (E Dagva), 1024, (D Tzevegmid), 1024, (I S Sles), 1024
Horse Spinal Cord Presence of Behinic Acid in Sphingomyelin from (Prof Yasuhiko Fujino and Takashi Negishi), 817
Horses Cardiac Output in (E W Fisher and R G Dalton), 2020
Horticultural Crops (Agricultural and) The Control of Pests and Diseases in (G L Hey and K Marshall), *review* by F C Bawden, 1258
Horvath, Dr I, and Szentirmai, A Inhibitory Effect of Fungistatic Antibiotics on the Production of Amylase by *Penicillium chrysogenum*, 57
Horvath, Dr I, and others A New Trichothecin-like Antifungal Antibiotic, 908
Hoskin, Dr M A Newtonian Documents, *review*, 1750
Hosking, J S, and Hueber, H V Permanent Moisture Expansion of Clay Products on Natural Exposure, 1373
Hoskins, Dr J M Appointed lecturer in bacteriology and virology at the University of Sheffield, 684
Hospitals and the State—Hospital Organization and Administration under the National Health Service, Sixth and Final Research Report (Creative Leadership in a State Service—a General Survey by Sir George Schuster), 1087, 1201
Host–Parasite Relationships Evolution of (British Association for the Advancement of Science, Section D (Zoology), Symposium on), 760
Hoste, J Radioactivation Analysis (Uses of Activation Analysis in Metallurgy), 951

Hot Laboratory Equipment (United States Atomic Energy Commission), new edition, 155
Hough, Prof Jack L Geology of the Great Lakes, *review* by Prof S E Hollingworth, 665
Houghton, E W (Edwards, J , and) Radar Echoing Area Polar Diagrams of Birds, 1059
Houldin, Dr J E (Gavin, Prof M R , and) Principles of Electronics, *review* by Prof D G Tucker, 751
House (The Country), and the Museum (Museums Association Discussion on), 598
House of Commons Third reading of the Nuclear Installations (Licensing and Insurance) Bill, 680
Houseflies Mechanisms of Resistance of Adult, to the Insecticide Dieldrin (F P W Winteringham and A Harrison), 608
  Pentachloro*cyclo*hexene as a Possible Intermediate Metabolite of Benzene Hexachloride in (R G Bridges), 1337
  Resistance of, to γ-Benzene Hexachloride and Dieldrin (R G Bridges and J T Cox), 1740
House-Fly Esterase Inhibition and Organophosphorus Poisoning in the (Dr D Stegwee), 1253
House-Fly Reproduction Role of Cholesterol in (Ronald E Monroe), 1513
Householder, Dr A S At the first Conference of the British Computer Society (Pitfalls in the Techniques commonly used on Computers), 946
Housing and Local Government, Ministry of Circular No 57/59, Advice concerning Hazards from Ionizing Radiations, 1450
Hovenkamp, H G Fractionation of the System bringing about Oxidative Phosphorylation in *Azobacter vinelandii*, 471
How Much Science? (Prof J Jewkes), B A 44
Howard, A Biological Effects of Low Doses of Ionizing Radiation, 1112
Howard, Ian P Some New Subjective Phenomena apparently due to Interocular Transfer, 1516
Howard, Dr Robert, and others Magnetic Field associated with a Great Solar Flare, 351
Howard, Dr Richard A Kew, Past and Present, *review*, 1345
Howarth, Sheila (Loveless, Anthony, and) Mutation of Bacteria at High Levels of Survival by Ethyl Methane Sulphonate, 1780
Howatson, Dr A M Appointed a lecturer in electrical engineering at the University of Sheffield, 684
Howe, Surg Comdr D C A Rare Hydromedusa, 1963
Howell, Dr H G , and others Friction in Textiles, *review*, 1765
Howes, Dr F N *Obituary* of William Dallimore, 1684
Howes, M A H , and others Identification of the High-Temperature Constituent in Mild Steel Surface-Hardened by Carbo-Nitriding, 1312
Howgrave-Graham, R P *Obituary* by Prof J Greig, 92
Howorth, Muriel Pioneer Research on the Atom—the Life Story of Frederick Soddy, *review* by Prof Norman Feather, 298
Howson, D P Modern Network Theory in Electrical Engineering (Networks with Parameters varying with Time), 1691
Howson, E A Appointed Research Fellow in electrical engineering in the University of Birmingham, 684
Hoyle, F (Haselgrove, C B , and) Structure and Age of the Stars, 1986
Hu, G C-Y Appointed lecturer in highway and traffic engineering at the University of Birmingham, 1915
Hu, Shiu-Ying Origin and Dispersal of Flowering Plants (Phytogeography of Chinese Species of *Fraxinus*), 1201
Huang, Prof R S Appointed to the chair of chemistry in the University of Malaya in Kuala Lumpur, 405 , work of, 405
Hubbard, J I Post-activation Changes at the Mammalian Neuromuscular Junction, 1945
Hubbard, Jerry S (Durham, Prof Norman N , and) Antagonism of the Oxidative Dissimilation of *p*-Aminobenzoic Acid by *p*-Aminosalicylic Acid, 1398
Hubbard, W N Thermodynamics (Experimental Thermochemistry), 1606
Hüber, Prof P At the 139th Annual Meeting of the Swiss Society for Natural Sciences (Potentialities and Limitations of Nuclear Research in Switzerland), 1454
Hubinont, P O , and others Production of an Agglutinating Auto-Antibody (Panagglutinin) Active upon Tanned Erythrocytes in the Rabbit, 1250
Hudnik-Plevnik, Tamara A , and others Fate of the Highly Polymerized Spleen Deoxyribonucleic Acid labelled with Phosphorus-32 Injected Intraperitoneally into Rats, 1818
Hudson, Dr J C (compiled by) Sixth Report of the Corrosion Committee of the Iron and Steel Institute, 1023
Hueber, H V (Hosking, J S , and) Permanent Moisture Expansion of Clay Products on Natural Exposure, 1373
Huelin, Dr F E , and Kennett, B H Nature of the Olefines produced by Apples, 996, *errata*, 1535
Huffadine, J B Special Ceramics (Very Low Electrical Resistivity of the Silicide MoSi$_2$), 1116
Huffman (Hugh M) Memorial Lecture of Yale University (Prof George S Parks), 1194
Hufton, P A Promoted to Chief Scientific Officer and appointed head of the Aerodynamics Department at the Royal Aircraft Establishment, 233 , work of, 233
Hug, O Biological Effects of Low Doses of Ionizing Radiations (Types of Immediate Response to Irradiation), 1112
Huggins, Prof C G Effect of Acetylcholine on the Incorporation of Radiophosphorus into the Phosphatido-Peptide Fraction of Pancreas Slices, 1412
Hughes, A C Fluctuation Phenomena and Stochastic Processes (Statistics of Radioactive Decay), 510
Hughes, Dr D E R Constitutional Diagrams of Uranium and Thorium Alloys, *review*, 925
Hughes, Dr D L Loss of Wool in Sheep caused by 1-*p*-Aminophenoxy-5-phthalimidopentane, 1644
Hughes, Prof E D Gas Chromatography, 328
Hughes, Gwilym Tribute paid to Jacob Bell, founder of the Pharmaceutical Society of Great Britain, on the hundredth anniversary of his death, 23
  Appointed president of the Pharmaceutical Society of Great Britain, 95
Hughes, M A , and others Separation of the *Meta*- and *Para*-Isomers of the Zylenes, Cresols and Toluidines by Gas Solid Chromatography, 1796
Hughes, N H Origin and Dispersal of Flowering Plants (Difficulties in the Discovery of Palaeobotanical Evidence of Angiospermous Origins), 1200
Hughes, T E Title of reader of zoology in the University of London (at Birkbeck College), conferred on, 322
  Mites, or the Acari, *review* by G O Evans, 1677
Hughes Medal for 1959 of the Royal Society awarded to Dr A B Pippard, 1189, 1834 , work of, 1834
Hull, L W H History and Philosophy of Science, *review* by Dr H D Anthony, 131
Hulme, Dr A C Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 858 , work of, 858
Hulten, E Origin and Dispersal of Flowering Plants (Alpigenous and Arctogenous Plants), 1200
Hultin, R Specificity in Protein Biogenesis (Observations on Animal Tissues which indicate that another pathway of Amino-acid Incorporation might exist beside that passing through Soluble Ribonucleic Acid), 1199
Hultqvist, Dr Bengt Auroral Frequency Lines, 263
Human The Importance of Being (Dr E L Mascall), *review* by the Very Rev W R Matthews, B A 2
Human Arterial Mucopolysaccharides Anticoagulant Activity of (Prof John E Kirk), 369
Human Blood Group Antigen, Sw$_a$ A 'New' (T Ê Cleghorn), 1324
Human Brain James Arthur Lecture on the Evolution of the—The Discrete and the Diffuse in Nervous Action (Prof D P C Lloyd), 1777
Human Carcinomas Aneuploid Deoxyribonucleic Acid Content of (H F Stich and H E Emson), 290
Human Cerebrospinal Fluid Glycoproteins of (Dr Samuel Bogoch), 1628
Human Diet Strontium-90 in, in the United Kingdom (Agricultural Research Council), 1111
Human Erythrocyte Membrane Active Transport of Uric Acid through the (Dr Kay Overgaard-Hansen and Dr Ulrik V Lassen), 553
Human Erythrocytes Glucose-6-phosphate Dehydrogenase and—Characteristics of Glucose-6-phosphate Dehydrogenase from Normal and Primaquine-sensitive Erythrocytes (Dr Henry N Kirkman), 1291 , Mechanism of Inactivation of Glucose-6-phosphate Dehydrogenase in Human Erythrocytes (Dr Paul E Carson, Stanley L Schrier and Robert W Kellermeyer), 1292
  Mechanism of Inactivation of Glucose-6-phosphate Dehydrogenase in (Glucose-6-phosphate Dehydrogenase and Human Erythrocytes), (Dr Paul E Carson, Stanley L Schrier and Robert W Kellermeyer), 1292
Human Erythroid Cells *in vitro* Lack of Direct Effect of Erythropoietin on (Edward L Alpen, L G Lajtha and Donald C Van Dyke), 1228
Human Foetal Haemoglobin Heterogeneity of—Incidence of Foetal Variants in Singapore (Dr F Vella) 272
Human Gamma-Globulin Staphylocoagulase Inhibition by Pooled (Prof Murray M Streitfeld, Prof Bennett Sallman and Seymour M Schoelson), 1665
Human Gastric Juice Electrophoresis of (Dr Ragnhild Gullberg and Dr Borge Olhagen), 1848
Human Haemoglobin The Heterogeneity of, *review* by Dr J A M Ager, 840
  A Terminal Peptide Sequence of (Dr J A Hunt and Dr V M Ingram), 640
Human Haemoglobin *E*—the Chemical Effect of Gene Mutation (Abnormal Human Haemoglobins), (Dr J A Hunt and Dr V M Ingram), 870
Human Haemoglobin (Adult and Foetal) Serological Distinction of (G R E Naylor and M E Adair), 1854
Human Haemoglobins Abnormal—Human Haemoglobin *E*, the Chemical Effect of Gene Mutation (Dr J A Hunt and Dr V M Ingram), 870 , Haemoglobin 'Bart's', a Foetal Haemoglobin without α-Chains (Dr J A Hunt and Dr H Lehmann), 872
Human Heart Histochemical Localization of Oxidase Activity in the Mitochondria of the (Dr M S Burstone), 476
Human Multiform Glioblastoma Electron Microscopical Structure of the Wall of Small Blood Vessels in (Dr S H M Nystrom), 65
Human Pituitary Gland Structure of a Melanocyte-stimulating Hormone from the (Dr J Ieuan Harris), 167
Human Placenta Phospholipid Phosphoric Esters in the (G Porcellati, B Curti and S Luciani), 1870
Human Precipitins against Common Pathogenic and Non-Pathogenic Fungi (Dr J Pepys, Dr R W Riddell and Dr Y M Clayton), 1328
Human Prothrombin (Purified) Activation of Staphylococcal-free Coagulase by (G Haughton and E S Duthie), 116
Human Red Cells Accumulation of Dextran in, after Haemolysis (N V B Marsden and S G Ostling), 723
  Calcium Ions and the Permeability of (Prof M Maizels), 366
Human Reproduction Essentials of (edited by Prof Joseph Thomas Velardo), *review* by Dr T Mann, 1434
Human Serum Activation and Inhibition of the Arylesterase of (Prof E G Erdos, C R Debay and M P Westerman), 430
Human Serum in Cell Culture Growth-Controlling Action of (Dr Kari Penttinen and Dr Erkki Saxén), 1570
Human Serum Denatured with Tannin Effect of Ultrasound on the Protein of (Dr Wizold Mizgalski and Irena Zygmunt), 1486
Human Serum (Normal) Influence of Coagulase on the Growth of Staphylococci in (Dr K Wlodarczek and Dr J Jeljaszewicz) 1514
Human Serum Proteins (Substituted) Modifications in immunological Behaviour, Electrophoretic Mobility and Colourability of (M Steinbuch, Dr J M Fine and A Battistini), 1571
Human Skeletal Muscle Mitochondria Enzymic Activities of—a Tool in Clinical Metabolic Research (Dr L Ernster, Dr D Ikkos and Dr R Luft), 1851
Human Standard Clots Urokinase-Induced Fibrinolysis of (Dr Kuro N von Kaulla), 1320
Human Subjects Assay of Plasma Insulin in, by Immunological Methods (Dr Rosalyn S Yalow and Dr Solomon A Berson), 1648
Human Thrombocytes Extraction of an Actomyosin-like Protein from (M Bettex-Galland and Dr E F Luscher), 276
Human Tissue Culture Cells Cellular Uptake of Deoxyribonucleic Acid by (Dr Stanley M Gartler), 1505
Human Tissues (Cultured) Sex Chromatin in (Dr Charles P Miles), 477

Human Understanding Concerning (Prof Nikunja Vihari Banerjee), *review* by Dr D J McCracken, 1571

Humane Experimental Technique The Principles of (Dr W M S Russell and R L Burch), *review* by Prof M Weatherall, 1675

Humane Experiments, *review* by Prof M Weatherall, 1675

Humanism Impact of Science and Technology on, 1595

Humanities Science and the, *review* by Dr H D Anthony, 131

Humans Sterol-Balance Experiments in (Dr Harald Schon), 1872

Humans (Non-diabetic), of Varying Ages Actual Distribution of the Number and Volume of the Islets of Langerhans in Different Size Classes in (Bo Hellman), 1498

Hume, David The manuscripts of, to be micro-filmed by the Royal Society of Edinburgh, 95

Hume-Rothery, Prof W Spectrographically Pure Metals, 1794

Humid Central Congo Basin Nitrogen Content of Rain Water collected in the (J Meyer and E Pampfer), 717

Humorally Co-ordinated Chromatic Responses Significance of the Time Relations of (Dr A K Kent), 2027

Humphrey, Beverley A Occurrence of 4-O-Methyl Glucuronic Acid in *Rhizobium* Gums, 1802

Humphrey, Dr J H A New Approach to Immunity, *review*, 753

Humphries, Dr E C Glasshouse Crops Research Institute, 161

Hundred Years of the University of Calcutta—Supplement, *review* by Dr R S Aitken, 218

Hungry Feeding the (Gerard Piel), 162

Hunt, D U British Iron and Steel Research Association—London Group Laboratories Open Days, 1536

Hunt, Dr G R, and Ross, Dr I G At the Second Australian Spectroscopy Conference (Spectra of Aromatic Hydrocarbons—Vibrational Analysis of the 7000 A and 3500 A Absorption Systems of Azulene), 1195

Hunt, J Specificity in Protein Biogenesis (Structure of Abnormal Haemoglobins), 1198

Hunt, J A Awarded a Stothert Research Fellowship by the Royal Society, 595

  Awarded a Carlsberg–Wellcome Travelling Research Fellowship, 683

Hunt, Dr J A, and Ingram, Dr V M A Terminal Peptide Sequence of Human Haemoglobin?, 640

  Human Haemoglobin *E*—the Chemical Effect of Gene Mutation (Abnormal Human Haemoglobins), 870

Hunt, Dr J A, and Lehmann, Dr H Haemoglobin 'Bart's', a Foetal Haemoglobin without α-Chains (Abnormal Human Haemoglobins), 872

Hunt, Dr R W G The Reproduction of Colour, *review* by Dr W S Stiles, 1092

Hunter, R F Conservation in the Scottish Highlands (Conservation of Sheep Grazing), 1529

Huntjens, F J, and others Coal Science (Carbonization—Strength of Coke in relation to Particle Size of Coal Carbonized), 413

Hunwicks, S A Promoted to Deputy Chief Scientific Officer and appointed director of Atomic Weapons (Development), Ministry of Aviation, 1775, work of, 1775

Hurle, Dr I R, and Gaydon, Dr A G Vibrational Relaxation and Dissociation of Carbon Dioxide behind Shock Waves, 1858

Hurley, Richard B Junction Transistor Electronics, *review* by J W R Griffiths, 838

Hurych, J (Chvapil Dr M, and) Hydroxylation of Proline *in vitro*, 1145

Huseman, E Macromolecules (Starch and Cellulosic Chemistry), 1690

Husserl, Edmund Erste Philosophie (1923-24), Teil 2, Theorie der Phänomenologischen Reduktion (herausgegeben von Rudolf Boehm), (Husserliana, Band 8), *review* by F I G Rawlins, 1571

Husserliana Completed, *review* by F I G Rawlins, 1571

Hutchinson, E M Museums and Finance, 598

Hutchinson, Dr J The Families of Flowering Plants, second edition, Vol 1, Dicotyledons, Vol 2, Monocotyledons, *review* by Prof T G Tutin, 1759

Hutchinson, Sir Joseph *Obituary* of John Cecil May, 589

Hutchinson, P Awarded the Maskell Peace Scholarship for 1959 of the Institution of Mining Engineers, 1845

Hutchinson, Dr R C Food for Survival after a Disaster, *review* by M W Grant, 841

Hutt, Dr M S R, and others Detection of Thyroid Antibodies using Bentonite Particles, 478

Hutten, Dr E M Biology and Physics, 1193

Huxley, H E Comparative Studies in Ultrastructure (Comparative Study of the Activation of Contraction in Muscle), 1447

Huxley, H E, and others Comparative Studies in Ultrastructure (Comparative Studies in the Contractile Structures of Striated and Smooth Muscles), 1446

Huxley, Sir Julian Embryology, *review*, 1176

Huxley, Prof L G H Appointed a member of the Executive of the Australian Commonwealth Scientific and Industrial Research Organization, 1984, work of, 1984

Huxley, T H—Scientist, Humanist and Educator (Dr Cyril Bibby), *review* by Lord James of Rusholme, B A 2

Huxtable, Dr G Nuclear Forces and the Few-Nucleon Problem (Scattering of Nucleons by Light Nuclei at High Energy), 1113

Hvidberg, Eigill, and Schou, Jens Subcutaneous Absorption of Urethane in Dehydrated and Fasted Mice, 646

Hyacinth (Water), *Eichornia crassipes* Effects of the, in the Nile Valley (H R J Davies), 1085

Hybrid Population (*Baptisia*) Applications of Paper Chromatography to Systematics—Recombination of Parental Biochemical Components in a (Dr R E Alston and Dr B L Turner), 285

Hybridization Changes Effect of, on the Bond Energies of Carbon–Carbon Single Bonds (J E Bloor and S Gartside), 1313

Hybrids of *Tilapia nilotica* x *T galilea* (A Yashouv and J Chervinsky), 1739

Hybrids (Interspecific), of *Lycopersicum* (Helgi Nirk), 1819

Hybrids (Killifish) Effect of Thiouracil and Thyroxine on Development and Growth of Cutaneous Melanoma in (Prof A Stolk), 562

Hydén, Prof Holger Quantitative Assay of Compounds in Isolated, Fresh Nerve Cells and Glial Cells from Control and Stimulated Animals, 433

Hydractinia echinata Effect of Acetylcholine and Eserine on the Spawning of (M Yoshida), 1151

Hydrate of Cellulose Evidence for a, from Studies of its Surface Properties (Dr J M Joubert, Dr G J R Krige and Dr K Borgin), 1561

Hydrated Portland Cement Carbonate Minerals in (W F Cole and B Kroone), B A 57

Hydrates (Gas) Some Stoicheiometric (Dr D N Glew), 545

Hydrazinium Solution (Sodium-free) Excitability and Phosphorylation of Muscle and Nerve in (L G Abood and K Koketsu), 725

Hydrazones (Keto-Acid) Thermal Decarboxylation of some (Ambrose M Tokushige and Prof Elton S Cook) 267

Hydrocarbons Use of Tritium to Study the Solubility of Water in (B D Caddock and P L Davies), 2011

Hydrocarbons for Growth Incorporation of Molecular Oxygen in Bacterial Cells utilizing (E R Leadbetter and J W Foster), 1428

Hydrocarbons (Light) Analysis of (G R Primavesi), 2010

Hydrocarbons (Polycyclic Aromatic) Effect of, on the Polarographic Maximum of Copper (C E Searle), 1716

Hydrocarbons and other Organic Compounds Nitration of (A V Topchiev), translated from the Russian by Catherine Matthews, *review* by Prof M J S Dewar, 577

Hydrocortisone Liver Glucosyl Oligosaccharides and Glycogen—Carbon-14 Dioxide Experiments with (Dr Hsien-Gieh Sie, Prof James Ashmore, Dr Robert Mahler and Prof William H Fishman), 1380

  Mechanism of the Atherogenic Action of Excess (Dr Henry Grossfeld), 38

Hydrogen Structure of Bituminous Coals—Evidence from Distribution of (Dr P H Given), 980

Hydrogen (Neutral Atomic), in Globular Clusters A Search for (Dr Morton S Roberts), 1555

Hydrogen, Carbon Dioxide and Air Habit of Ice Crystals grown in, at Reduced Pressure (A P van den Heuvel and Dr B J Mason), 519

Hydrogen Peroxide Lowered Bactericidal Efficiency of, on Milk from Cows treated with Penicillin (J Babad, D L Boros and F Baier), 292

Hydrogen Peroxide, H_2O_4? A Higher (Dr J G Marshall and Dr P V Rutledge), 2013

Hydrogen Peroxide and Ferric Salts Oxidation of Ethyl Alcohol by a Mixture of (Dr Mordechai L Kremer), 720

Hydrogen Transport by Phenolic Œstrogens Two Enzymic Mechanisms for (Dr H G Williams-Ashman, M Cassman and Margaret Klavins), 427

Hydrogenation of Lipids by Rumen Protozoa (Dr D E Wright), 875

Hydrogenolysis of Carbon-Oxygen Bonds in some Aromatic Compounds by Electrolysis (Dr P H Given and Dr M E Peover), 1064

Hydrological Networks Design of (Max A Kohler), (World Meteorological Organization, Technical Note No 25), 96, *erratum*, 684

Hydrology (Scientific), International Association of Symposium on the Effects of Forest Areas on Water Resources, 1184

  Symposium on the Technique of Lysimetry, 1184

Hydrolysis 1-Glyceryl-2-*myo*-inositol Phosphate—Alternative Synthesis and Behaviour on (Synthesis and Properties of 1-Glyceryl-2-*myo*-inositol Phosphate), (R B Ellis and J N Hawthorne), 790

Hydrolysis of Adenosine Triphosphate Equilibrium Constant of the Galactokinase Reaction and Free Energy of (Dr M R Atkinson Eleanor Johnson and Prof R K Morton), 1925

Hydrolysis *in vitro* of Derivatives of 2-Aminofluorene Possible Relation between Carcinogenicity and Ease of (Prof Mary F Argus and Francis E Ray), 2018

Hydrolysis of 'Heated' Haemoglobin (S Baar), 986

Hydrolysis of *p*-Nitrophenyl Acetate Catalysed by Chymotrypsin Reactivity and Interrelationship of Intermediates in the (Mario A Marini and Prof George P Hess), 113

Hydromagnetic Heating Upper Atmosphere Density Variations due to (Dr A J Dessler), 261

Hydromedusa A Rare (Surg Comdr D C Howe), 1963

Hydromedusae Atlantic, *review* by J H Fraser, 300

Hydromedusae of the Atlantic Ocean and adjacent Waters (P L Kramp), (*Dana* Report No 46), *review* by J H Fraser, 300

Hydroperoxide (*trans-trans* Methyl Linoleate) Preparation of Crystalline (A Banks, S Fazakerley, J N Keay and J G M Smith), 816

Hydroperoxide (Thymine), produced by X-Irradiation Structure of (B Ekert and R Monier), B A 58

α-Hydroxyacetylene Complexes of Platinum (II) Structure of (Dr J Chatt, L A Duncanson and R G Guy), 526

Hydroxy-Cinnamic Acids Metabolism of Cinnamic Acid and, by *Lactobacillus pastorianus* var *quinicus* (Dr G C Whiting and Dr J G Carr), 1427

10-Hydroxy-Δ^2-decenoic Acid Biological Origin and Configuration of (Dr S A Barker, Dr A B Foster, D C Lamb and Dr L M Jackman), 634

Hydroxylamine Inactivation of some Animal Viruses by, and the Structure of Ribonucleic Acid (Dr Richard M Franklin and Dr Eberhard Wecker), 343

Hydroxylation of Proline *in vitro* (Dr M Chvapil and J Hurych), 1145

Hydroxylysine in Wool (Helga Kersten and L Zurn), 1490

4-Hydroxypipecolic Acid in *Acacia* Species Occurrence of (Dr J W Clark-Lewis and P I Mortimer), 1234

8-Hydroxyquinaldic Acid, the Red Fluorescent Substance in the Urine of Pyridoxine-deficient Rats (Dr J K Roy, Dr R R Brown and Prof J M Price), 1573

3-Hydroxytetrahydrothiophene-1,1-dioxide *in vivo* Metabolic and Chemical Studies of 'Myleran'—Formation of, and Reactions with Thiols *in vitro* (Dr J J Roberts and Dr G P Warwick), 1288

Hyman, Dr Libbie Henrietta The Invertebrates, Vol 5, Smaller Coelomate Groups—Chaetognatha, Hemichordata, Pogonophora, Phoronida, Ectoprocta, Brachipoda, Sipunculida, the Coelomate Bilateria, *review* by Dr N B Eales, 573

Hyman, Dr R A Semiconductors, *review*, 1754

Hynes, R D (Burge, Dr R E, and) The Optical Rotatory Power of Collagen, 1562

Hyoscyamus niger Complex Reaction in, upon Night Interruption with Red Light (P J A L de Lint), 731

Hyperplasia (Cellular) Viral Multiplication and (Prof Councilman Morgan), 435

Hypersensitivity Delayed (British Society for Immunology Symposium on), 1029

  Insulin and (R K Sanyal, P S J Spencer and Dr G B West), 2020

Hypersonic Gun Tunnel Measurement of the Effects of Piston Mass and Bursting Pressure on the Motion of a Piston in a (B J Belcher), 1207
Hypertensin II Synthesis of a Protected Heptapeptide related to the Histidine Analogue of (Dr Dimitrios Theodoropoulos), 1634
Hypertension (Essential) Haemodynamics in (Dr J Brod, V Fencl, Z Hejl and J Jirka), 1643
Hypervitaminosis A Carbohydrate Metabolism in (Amal Ray and Prof D P Sadhu), 1323
Hypocotyls (Bean, *Phaseolus vulgaris*) Influence of Kinetin, β-Indoleacetic Acid and Gibberellic Acid on Nuclease Activity of (Dr W Maciejewska-Potapczyk), 557
Hypophysial Extracts (Fish and Frog) Chromatographic and Biological Characteristics of (Active Principles of the Neurohypophysis of Cold-blooded Vertebrates), (B T Pickering and Prof H Heller), 1463
Hypothalamic Extract (Whole) Effects of Methylthiouracil or Thyroidectomy on Activation of Pituitary Acid Phosphatases *in vitro* by (Dr V Schreiber and Dr V Kmentova), 728
Hypothesis The Aurora, the Radiation Belt and the Solar Wind—a Unifying (M H Rees and G C Reid), 539
Hypoxia Decrease in Radiosensitivity of the Intact Mouse Spleen produced by (Dr L Weiss), 1156
Hyptis suaveolens Poit Anti-A Haemagglutinins from a Non-Leguminous Plant (Dr G W G Bird), 109
Hytten, Dr F E (Taggart, Nan, and) Saliva-Serum Ratios of Deuterium Oxide after Administration of Heavy Water, 457

IACHAN, A , and others Electrophoretic Heterogeneity of Trypsin, 1225
Ibrahim, Dr Ragai K , and Towers, Prof G H N Conversion of Salicylic Acid to Gentisic Acid and *o*-Pyrocatechuic Acid, all Labelled with Carbon-14, in Plants, 1803
Ice (Antarctic Glacier) Creep Tests on (Malcolm Mellor), 717
Ice Age (Late Pre-Cambrian) Palaeomagnetism in some Norwegian Sparagmites and the (W B Harland and D E T Bidgood), 1860
Ice Caps (Polar) Temperatures in (Dr Uwe Radok), 1056
Ice Crystals grown in Hydrogen, Carbon Dioxide and Air at Reduced Pressure Habit of (A P van den Heuvel and Dr B J Mason), 519
Ice Sheet (Antarctic) Surface Topography of the (Dr J F Nye), 786
I C S U Review, No 1 (International Council of Scientific Unions), 319
Ideas for Industry New, *review* by Prof A J Brown, 1348
Identification of the High-Temperature Constituent in Mild Steel Surface-Hardened by Carbo-Nitriding (M A H Howes, G T F Jay, K Sachs and D Wilkinson), 1312
Identification of Phenazocine, a Potent New Analgesic (Dr E G C Clarke), 451
Identification of the Polyphenoloxidase Substrate of the Banana Detection and (Dr L A Griffiths), 58
Identification of Sugar Phosphates Periodate Technique for the (Eugene A Davidson), 1395
Identification (Chromatographic), of the Antilipaemic *X* Factor of the Unsaponifiable Fraction of Crude Vegetable Oils (Prof M C Nath, A Saikia and B I Uppin), 1635
Identification (Cytological), of Proliferating Donor Cells in Chick Embryos injected with Adult Chicken Blood (P M Biggs and L N Payne), 1594
Identification (Partial), of Lysins and Agglutinins in Lymphomatous Mouse Tissue (Dr Eric Ponder and Ruth V Ponder), 819
Identification (Spectroscopic), of Alpha-Emitting Nuclides in Biological Material (Prof W V Mayneord and C R Hill), 667
Iggo, Dr Ainsley Appointed to a Locke Research Fellowship by the Royal Society, 772
Iijima, Dr Teiji, and others Induction of Phage Formation in the Lysogenic *Escherichia coli K*-12 by Mitomycin *C*, 1079
Ikeda, Y (Kohiyama, M , and) Anomalous Genetic Interactions observed in *Bacillus subtilis*, 208
Ikkos, Dr D , and others Enzymic Activities of Human Skeletal Muscle Mitochondria—a Tool in Clinical Metabolic Research, 1851
Illness Darwin's (Prof S Adler), 1102
Illuminating Engineering Society H R H The Duke of Edinburgh to become the first Honorary Fellow, 237
  First Award of the Gold Medal made to Dr J W T Walsh, 1106
  Installation of H G Campbell as president for 1959-60, 1272
  Leon Gaster Memorial Premium for 1959 awarded to Dr R G Hopkinson and J Longmore, 1272
Illumination (Increased) Reduction in the Anoestrus Period of Laboratory Cats by (Dr Patricia P Scott and Marny A Lloyd-Jacob), 2022
Illustrated London News Series of astronomical articles in the (Prof H Bondi), 1913
Illustration (Visual), of University Lectures (British Universities Film Council Discussion on), 515
Image-Splitting Microscope for Accurate Measurement (J Dyson), 1561
Image (Colour-) Synthesis with Two Unorthodox Primaries (Arthur Karp), 710
Imai, A (Kanazawa, Dr K , and) Pure Culture of the Pathogenic Agent of Tyzzer's Disease of Mice, 1810
Imai, Sadao, and others Plant Growth Activities of 5- and 8-Halogeno-Dihydro- and Tetrahydro-1-naphthoic Acids, 1415
Imbalance' ('Amino-Acid) Effect of, on Growth and Vitamin A Storage in the White Rat (M Rechcigl, jun , S Berger, J K Loosli and H H Williams), 1404
Immediate and Low-level Effects of Ionizing Radiations (Dr Tikvah Alper), 1111
Immunity A New Approach to, *review* by Dr J H Humphrey, 753
  Transplantation—Separation of Antigenic Components from Isolated Nuclei (André Castermans and André Oth), 1224
Immunity (Acquired) The Clonal Selection Theory of (Sir Macfarlane Burnet), *review* by Dr J H Humphrey, 753
Immunity (Passive), in an Insectivore Transmission of (B Morris), 1151
Immunization with Biologically Active Fractions of Deoxyribonucleic Acid and Subsequent Specific Infection of Mice (Dr M Kohoutova), 1965
Immunochemical Studies of Polypeptidyl Proteins and Synthetic Polypeptides (Prof M A Stahmann, D J Buchanan-Davidson, Dr C Lapresel and Dr P Grabar), 549
Immunological Behaviour, Electrophoretic Mobility and Colourability of Substituted Human Serum Proteins Modifications in (M Steinbuch, Dr J M Fine and A Battistini), 1571
Immunological Distances among some Gallinaceous Birds (Danilo Mainardi) 913
Immunological Methods Assay of Plasma Insulin in Human Subjects by (Dr Rosalyn S Yalow and Dr Solomon A Berson), 1648
Immunological Paralysis and Unresponsiveness Specific Inhibition of Antibody Formation during (Dr E Sercarz and Dr A H Coons), 1080
Immunological Suppression Tumour Specificity and (Elaine Levi, A M Schechtman, Richard S Sherins and Stanley Tobias), 563
Immunological Unresponsiveness Mechanism of (Prof Charles F Crampton, Fred R Frankel and J L Rodeheaver), 873
Immunology Delayed Hypersensitivity in, 1029
Immunology, British Society for Symposium on Delayed Hypersensitivity, 1029
Immunology and Development (edited by M V Edds, Jr), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Impact Ductile Molybdenum (J A Belk), 897
Impact of Science and Technology on Humanism, 1595
Impact (Electron) Isomerization to the Tropylium Ion Induced by, and its Significance (Dr W Hanuš), 1796
Impairment Mechanism (Strength), of Glass in Aqueous Systems (Frederick J Radd and Donald H Oertle), 976
Impedance Methods (Mechanical), for Mechanical Vibrations—Colloquium presented at the Annual Meeting of the American Society of Mechanical Engineers, 1958 (edited by R Plunkett), *review* by Prof R E D Bishop, 1764
Imperial Cancer Research Fund Fifty-sixth Annual Report (1957-58), 783
Imperial Chemical Industries, Ltd 'Procinyl' Dyes, 152
Imperial College of Science and Technology, London Postgraduate Courses (1959-60), 235
  Appointment of Dr P J Grant as reader in engineering science, 322
  Appointment of Dr B W Martin as reader in applied thermodynamics, 322
  Appointment of Dr P Grootenhuis to the University of London readership in mechanical engineering, 508
  Appointment of Dr A P Millman to the University of London readership in mining geology, 595
  Title of professor of physics in the University of London conferred on Dr M Blackman, 1273
  Title of professor of physical chemistry in the University of London conferred on Dr F C Tompkins, 1273
  Appointment of A V Bradshaw to the University of London readership in extraction metallurgy, 1535
Implement (A Bone), from Sterkfontein (Dr J T Robinson), 583
Implements (Stone), from Western Nigeria (E L Kostick, C N Williams and S A Williams), 124
Implications of Restricting Cows to a Clover-free Diet in order to Reduce the Strontium Content of Milk (Dr David Purves), 1408
Importance of Being Human (Dr E L Mascall), *review* by the Very Rev W R Matthews, B A 2
Importance of New Detectors, *review*, 1260
Importance of the Type of Metabolism for the Radiosensitivity of Mice (Dr M Pospisil and Dr L Novak), 1814
Importance (The Critical), of Transport and Communications (Sir Ewart Smith), B A 44
Improved Caesium Frequency and Time Standard (Dr L Essen and J V L Parry), 1791
Improved Technique for Intravenous Injection of Newborn Rats and Mice (N F Anderson, E J Delorme, Prof M F A Woodruff and D C Simpson), 1952
Improvement and Management of Salt-affected Soils Diagnosis, (Unesco Middle East Science Co-operation Office Regional Training Course on), 1778
Improvements in Colorimetric Determination of Elastin Some (Dr V Scarselli), 1563
Imsheneysky, Prof Alexandre A , and others Statement on Biological and Chemical Warfare, 1018
Inactivated by Mercury Reactivation of Vaccinia Virus (Colin Kaplan), 1074
Inactivation of some Animal Viruses by Hydroxylamine and the Structure of Ribonucleic Acid (Dr Richard M Franklin and Dr Eberhard Wecker), 343
Inactivation of Glucose-6-phosphate Dehydrogenase in Human Erythrocytes Mechanism of (Glucose-6-phosphate Dehydrogenase and Human Erythrocytes), (Dr Paul E Carson, Stanley L Schrier and Robert W Kellermeyer), 1292
Inactivation (Heat), of Rinderpest-infected Bovine Tissues (Dr G R Scott) 1948
Inadequacy of Scatter Mechanisms in Tropospheric Radio Propagation (P C M de Belatini), 1558
Inauguration of *Merlin* by H R H the Duke of Edinburgh, 1191
Incentives in the Building Industry (Alison Entwistle and W J Reiners), (National Building Studies Special Report No 28), 98
Incidence of Bone Tumours An Effect of Dose Fractionation on the, using Radioactive Phosphorus (Dr N M Blackett), 565
Incidence (Tumour) Latent Period of X-Ray Induced Ageing—a Study based on Mortality Rate and (Dr H I Kohn and Dr P H Guttman), 735
Incisor Teeth of Rats deficient in Vitamin E Curative Effect of Selenium upon the (Prof J T Irving), 645
Incomplete Antibodies Loss of Plasticity of Erythrocytes coated with (Prof C T Nicolau, P Teitel and M Fotino), 1808
Incorporation of 5-Bromouracil into Transforming Principal of *Bacillus subtilis* and its Biological Effects (Dr Erela Ephrati-Elizur and Prof Stephen Zamenhof), 472
Incorporation of Metabolites by Isolated Thymus Nuclei Monovalent Cations and the (Dr Theodore R Breitman and Dr George C Webster), 637
Incorporation of N-Methyl Carbon of Monoethylaminoazobenzene into Polar Dyes (Prof Hiroshi Terayama, Prof Morizo Ishidate and Akira Hanaki), 1460

Incorporation of DL-[2-^{14}C] Mevalonic Acid Lactone into Polyisoprene (R G O Kekwick, B L Archer, D Barnard, G M C Higgins, G P McSweeney and C G Moore), 268, *erratum*, 772
Incorporation of Molecular Oxygen in Bacterial Cells utilizing Hydrocarbons for Growth (E R Leadbetter and J W Foster), 1428
Incorporation of Radiophosphorus into the Phosphatido-Peptide Fraction of Pancreas Slices Effect of Acetylcholine on the (Prof C G Huggins), 1412
Incorporation of Uridine labelled with Tritium Chromosomal Synthesis of Ribonucleic Acid as shown by (G Pelling), 655
Incorporation (Massive), of 5-Fluorouracil into a Bacterial Ribonucleic Acid (Dr Jack Horowitz and Prof Erwin Chargaff), 1213
Increase in the γ-Aminobutyric Acid Content of Rat Brain after Ingestion of Ethanol (Dr H -M Häkkinen and E Kulonen), 726
Increase by Chlorothiazide of the Paralysing Activity of *d*-Tubocurarine Chloride (Prof W Ferrari, G L Gessa and G Sangiorgi), 1235
Increase in the Tension in a Ligament Does an, elicit Reflex Muscular Responses ? (Dr Bertil Sténer), 1495
Increase (Anticipatory), of Intensity associated with the Cosmic-Ray Storm of February 11, 1958 North–South Anisotropy and (Dr V Sarabhai and R Palmeria), 1204
Increase (Effective), in Nematode Populations by the Addition of Aureomycin (C O R Everard and William A Feder), 1887
Increased Capillary Permeability Pharmacological Suppression of, following Irradiation of the Intestine of Rats (Dr D A Willoughby), 1156
Increased Circulating Insulin-like Activity in Obese-Hyperglycaemic Mice (Jean Christophe, Yves Dagenais and Jean Mayer), 61
Increased Illumination Reduction in the Anoestrus Period of Laboratory Cats by (Dr Patricia P Scott and Marny A Lloyd-Jacob), 2022
Increased Oxygen Consumption in Rats during Irradiation (Dr A Vacek), 197
Increasing the Phosphorus Content of Forages A Method of (Prof R Ferrando, S Metivier and R Gervy), 76
Incubated at 22°-30° C Appearance of Crystalline Needles in Monkey Kidney Cell Cultures infected with Poliomyelitis Virus and (Dr Esther Tenenbaum), 1657
Index of Chemistry Films (Royal Institute of Chemistry), *review*, 1902
Index Kewensis Supplementum Duodecimum, 1951-1955 (edited by Dr George Taylor), *review* by Prof T G Tutin, 129
India Biochemical Research in—Golden Jubilee Symposium (Prof P S Sarma), 1367
  Bovine Stars of (Indian Council of Agricultural Research, Misc Bulletin No 82), 941
  Indications of Glacierization in the Siwalik System in (R. C Mehridatta), 833
  Management in, 1913
Indian Botanical Society Birbal Sahni Medal for 1958 awarded to Prof P Maheshwari, 95
Indian Council of Agricultural Research Misc Bulletin No 82, Bovine Stars of India, 941
Indian Council of Agricultural Research and Unesco International Symposium on Algology, 595
Indian Culture The Pre-historic Background of (Colonel D H Gordon), *review* by M C Burkitt, 131
Indian Institute of Science Symposia on Biology and Biochemistry of Micro-organisms, Enzymes, and Vitamins, 1367
Indian Ocean (eastern) Oceanographic and Geophysical Investigation of the western Pacific Ocean and (Scripps Institution of Oceanography), 24
Indian Prehistory, *review* by M C Burkitt, 131
Indian Rhinoceros The Great (E P Gee), 1986
Indian Society of Soil Science Presidential Address (Dr N R Dhar), 942
Indian Society of Theoretical and Applied Mechanics Fifth Congress on Theoretical and Applied Mechanics, 1192
Indian Termite Fauna New Neotropical Element (*Anoplotermes*) in (Dr M L Roonwal and O B Chhotani), 1967
Indians (South American) Frequency of the New Blood Group Antigen Js^a among (Dr Miguel Layrisse and Dr Zulay de Layrisse), 640
Indications of Glacierization in the Siwalik System in India (R C Mehridatta), 833
Indicator (Metal Ion) Determination of the Interaction of Deoxyribonucleate and Magnesium Ions by means of a (Joseph Shack and Barbara S Bynum), 635
Individual Insects The Infra-Red Gas Analyser as a Means of Measuring the Carbon Dioxide Output of (Dr A G Hamilton), 367
3-Indole Acetic Acid in *Avena* Electrical Determination of Transport of (I A Newman), 1728
Indole Acetic Acid and α-Naphthalene Acetic Acid Effect of, on the Growth, Flowering and Fruit Set in Sweet Potato (G Satyanarayana and Dr G Rangaswami), B A 73
β-Indoleacetic Acid and Gibberellic Acid (Kinetin,) Influence of, on Nuclease Activity of Bean (*Phaseolus vulgaris*) Hypocotyls (Dr W Maciejewska-Potapczyk), 557
Indoleacetic Acid Oxidase A Possible Role of, in Crown Gall Tumour Induction (Dr Jacques Lipetz), 1076
Indoleacetonitrile α-Oxidation of (H F Taylor and Prof R L Wain), 1142
3-Indolecarboxylic Acids Occurrence of 3-Indolylacetic and, in Tomato Crown-Gall Tissue Extracts (G Clarke, M H Dye and Prof R L Wain), 825
3-Indolylacetic and 3-Indolecarboxylic Acids Occurrence of, in Tomato Crown-Gall Tissue Extracts (G Clarke, M H Dye and Prof R L Wain), 825
Induced Ageing (X-Ray) Latent Period of—a Study based on Mortality Rate and Tumour Incidence (Dr H I Kohn and Dr P H Guttman), 735
Induced Inhibition (X-Ray), of Deoxyribonucleic Acid Synthesis in *Escherichia coli* 15$_T$ Influence of Unbalanced Growth on subsequent (Daniel Billen), 174
Induced Mutations of X-Ray Irradiations in *Culex fatigans* Wied (1828), (R Pal and B S Krishnamurthy), 658
Induced Tolerance of D-Tubocurarine Chloride in the Cat (Fiona Acheson and Dr R J M Fry), 1409
Induction of Parthenocarpy in *Rosa arvensis* Huds with Giberellic Acid (M V Prosser and G A D Jackson), 108
Induction of Phage Formation in the Lysogenic *Escherichia coli K*-12 by Mitomycin C (Dr Nozomu Otsuji, Dr Mutsuo Sekiguchi, Dr Teiji Iijima and Dr Yasuyuki Takagi), 1079
Induction (Crown Gall Tumour) A Possible Role of Indoleacetic Acid Oxidase in (Dr Jacques Lipetz), 1076
Induction (Early), of Flowering in Birch Seedlings (Dr K A Longman and Prof P F Wareing), 2037
Induction (Enzyme) X-Ray Sensitivity and Volume Target of (Dr Helmut Pauly), 1570
Industrial Bacteria, National Collection of Transferred from the National Chemical Laboratory to the Torry Research Station, 1192
Industrial Conference Board, Inc (National), Cleveland Seventh Annual Conference on Atomic Energy in Industry (Radiation, a Tool for Industry), 506
Industrial Health in the Potteries, 420
Industrial Microbiology Progress in (edited by Dr D J D Hockenhull), Vol 1, *review* by Dr N Blakebrough, 1598
Industrial Psychology, National Institute of Grant of £6,000 a year for five years from the Department of Scientific and Industrial Research, 940
  Vernon Prize for 1960, 1450
Industrial Research Associations in the Government Scheme Research for Industry 1958, a Report on Work done by the (Department of Scientific and Industrial Research), 211, 238
Industrial Research Reactor *Merlin*, an (Dr T E Allibone), B A 11
Industrial Technical Organization (Institute of the Rubber Industry Conference on), 322
Industry Application of Science in, 1827
  Atomic Energy in (National Industrial Conference Board, Inc , seventh Annual Conference on), 506
  British, *review* by Prof A J Brown, 1089
  Efficient Use of Man-Power in (Report of an inquiry by the National Joint Advisory Council), 25
  Fitting the Job to the Worker—a Survey of American and European Working Conditions in (European Productivity Agency of the Organization for European Economic Co-operation, Project 335), 422
  Health and, 1023
  New Ideas for, *review* by Prof A J Brown, 1348
  Radiation, a Tool for (National Industrial Conference Board, Inc , seventh Annual Conference on Atomic Energy in Industry), 506
  Relationships in—some Changing Concepts of Management (British Institute of Management and the Ministry of Labour Conference on), 156
  Research for, 1958—a Report on Work done by the Industrial Research Associations in the Government Scheme (Department of Scientific and Industrial Research), 211, 238
  Science in—Policy for Progress (Prof C F Carter and Prof B R. Williams), 1827
Industry (American) Funds for Research and Development Performance in (United States National Science Foundation, Reviews of Data on Research and Development No 14), 1022
Industry (British) The Structure of, a Symposium (edited by Duncan Burn), *review* by Prof A J Brown, 1089
Industry (Building) Incentives in the (Alison Entwistle and W J Reiners), (National Building Studies Special Report No 28), 98
Industry (Food) Enzymes in the (Food Group of the Society of Chemical Industry Symposium on), 1366
Industry (Petroleum) Centenary of the, 1611
  Handbook of the (edited by G Sell and H A Dossett), *review*, 1832
Industry and Commerce Staff in—Management of Workers whose Skills are mainly Mental or Social rather than Manual (E M Barling), 319
Industry and Commerce Tynside Association of Libraries for, 25
Industry and Health in Britain, 1456
Industry and Technical Colleges Relationship between (Liverpool District of the Federation of British Industries Conference on), 1690
Infant Rat Passage of Insulin through the Wall of the Gastro-intestinal Tract of the (Dr B Mosinger, Z Placer and O Koldovsky), 1245
Infection of Cattle with *Cysticercus bovis* by the Injection of Onchospheres (G Froyd and M C Round), 1510
Infection of Mice Immunization with Biologically Active Fractions of Deoxyribonucleic Acid and Subsequent Specific (Dr M Kohoutova), 1965
Infection with West Nile Virus Duration of Protective Action of Interferon against (Dr Alick Isaacs and Marguerite A Westwood), 1232
Infection (Bacillus Calmette-Guérin) Effect of, on Transplanted Tumours in the Mouse (Dr Lloyd J Old, Dr Donald A Clarke and Dr Baruj Benacerraf), 291
Infections (Intraperitoneal), of Mice Opsonins as Determinants of Survival in (Dr C R Jenkin and Prof D Rowley), 474
Infectious Nucleic Acid Recovery of, from Tobacco Mosaic Virus Inactivated by Antibody (Dr Irving Rappaport), 1732
Infectious Ribonucleic Acid from Mouse Brains infected with Tick-borne Encephalitis Virus (F Sokol, H Libikova and J Zemla), 1581
Infective 'Ribonucleic Acid' Failure to Recover, from Myxovirus Preparations (G L Ada, Patricia E Lind, Lois Larkin and Sir Macfarlane Burnet), 360
Infective Ribonucleic Acid in Pig Kidney Tissue Culture Monolayers Effect of Proflavine on the Formation of the Virus of Foot-and-Mouth Disease and its (F Brown and Doreen L Stewart), B A 74
Infective Stage in Tsetse Fly Tissue Culture Development of *Trypanosoma vivax* to the (Dr William Trager), B A 30
Infectivity of Polio Virus Ribonucleic Acid for Embryonated Eggs and Unsusceptible Cell Lines (P De Somer, Dr A Prinzie and E Schonne), 652
Infectivity and Haemagglutinin of Vaccinia Virus Effect of Concentrated Urea Solutions on the (Prof J F McCrea and Jean O'Loughlin), 1497
Infertility Proceedings of the Third Symposium on Reproduction and, Colorado State University (edited by F X Gassner, in association with Rue Jensen and H J Hill), *review* by Dr T Mann, 1434
Infestation of Rabbits with the Nematode *Trichostrongylus retortaeformis* (Zeder, 1800) A Seasonal Sex Difference in the (P C Bull), 281
Infestation Control, a Service to Agriculture and Food Storage (Ministry of Agriculture, Fisheries and Food), 941
Inflorescence Inception and Leaf Size in Gramineae (M Borrill), 321
Inflorescences, Flowers and Ovaries of an Apomict, *Aerva tomentosa* Forsk *In vitro* Culture of the (Prem Murgai), 72
Influence of Adult Lymphoid Tissues on Polyoma-induced Tumours (Dr V Defendi and Dr H Koprowski), 1579

Influence of Carotenoids on the Infra-Red Spectrum of Bacteriochlorophyll In *Chromatium* (Dr J A Bergeron and Dr R C Fuller) 1340
Influence of Coagulase on the Growth of Staphylococci in Normal Human Serum (Dr K Wlodarczek and Dr J Jeljaszewicz), 1514
Influence of Counterion Association on the Configurational Stability of Deoxyribonucleic Acid in Solution (F Ascoli, C Botre, V Crescenzi, A Mele and Prof A M Liquori), 1482
Influence of Crystal Defects on the Szilard-Chalmers Process in Solids (Dr A G Maddock and J I Vargas), 1931
Influence of Dietary Protein Percentage on Growth of Wool (K A Ferguson), 907
Influence of Gibberellic Acid and Photoperiod on the Growth, Flowering, Nodulation and Nitrogen Assimilation of *Vicia villosa* (the late Prof Margaretha G Mes), 2035
Influence of Gold in a Mercury Electrode on certain Electrode Processes (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus), B A 56
Influence of Kinetin, β-Indoleacetic Acid and Gibberellic Acid on Nuclease Activity of Bean (*Phaseolus vulgaris*) Hypocotyls (Dr W Maciejewska-Potapczyk), 557
Influence of DL-beta-Phenylserine on the Synthesis of Proteins in *Escherichia coli* (J Janeček, J Chaloupka, K Vereš and M Havranek), 1895
Influence of Platinum in Mercury on the Mechanism of Electrode Reactions at the Mercury Electrode (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus), 1795
Influence of Sexual Stimulation on the Metabolic Activity of Deoxyribonucleic Acid in the Seminal Vesicle (Dr S R Pelc), 1414
Influence of Site and Season on Agricultural Variety Trials (A Sandison), 834
Influence of the Size of the Halogen Atom on the Difference between Lattice Constants of Copper dipyridine dichloride and dibromide (Vladimir Kupcik and Slavomil Durovic), 1060
Influence of Streptomycin Solutions on the Interaction between the Agglutinating Sera and the Corresponding Red Blood Cell Receptors (Dr M Kout and Dr Z Kubickova), 639
Influence of Sulphur Dioxide Inhalation on the Phagocytic Activity of the Macrophage System (Prof D L J Bilbey and Dr H Salem), 722
Influence of Temperature on the Symbiotic Nitrogen Fixation of Legumes (the late Prof Margaretha G Mes), 2032
Influence of the Thomson Effect on the θ-φ Relationship for a Constrictive Resistance in Thermal Equilibrium (Dr W Davies), 975
Influence of the Thymus upon the Egg-White Allergy in the Rat (J Comsa), 1726
Influence of Unbalanced Growth on Subsequent X-Ray Induced Inhibition of Deoxyribonucleic Acid Synthesis in *Escherichia coli* 15_T (Daniel Billen), 174
Influence of White and Colored Lights and Darkness Behaviour and Reactions of the Pacific Sardine, *Sardinops caerulea* (Girard), under the (Dr A S Loukashkin and Dr N Grant), 865
Influence of X-Rays on the Activity of Carbonic Anhydrase in Erythrocytes and on their Haemolytic Resistance (A Lauwers, J Van Bavinchove and W Dierick), 111
Influences (Environmental), on Prenatal Development (edited by Beatrice Mintz), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Influenza Virus Serum Inhibitors of Asian Strains of (Suzanne M James and Paul Fiset), 1656
Information Loss of, brought about by Loss of Data (S C Pearce), 1826
Information on Water Resources Report of the Subcommittee on (Central Advisory Water Committee), B A 18
Information (Soviet Scientific) Providing United States Scientists with (United States National Science Foundation), revised edition, 1611
Information Services British Overseas, 1692
Infra-Red Absorption Bands The Intensity of—a Bibliography (compiled by Dr R G Gillis), 682
Infra-Red Development Co, Ltd Amalgamation with Hilger and Watts, Ltd, 1273
Infra-Red Gas Analyser as a Means of Measuring the Carbon Dioxide Output of Individual Insects (Dr A G Hamilton), 367
Infra-Red Spectra of Carbohydrate Sulphate Esters (Dr A G Lloyd and K S Dodgson), 548
Infra-Red Spectrophotometry Polyethylene Absorption Cells for (Trevor Robinson), 448
Infra-Red Spectrum of Bacteriochlorophyll in *Chromatium* Influence of Carotenoids on the (Dr J A Bergeron and Dr R C Fuller), 1340
Infra-Red System (Near), of Nitrogen (Dr P K Carroll and Dr H E Rubalcava), 119
Infra-Red Technique (Rapid) Post-Exposure Analysis of Organic Compounds in the Blood by a (Dr R D Stewart, D S Erley, T R Torkelson and C L Hake), 192
Ingalls, Dr James W (Greenberg, Prof Leo, and) Effect of Tranquillizing Drugs on Survival from Experimental Diphtheric Intoxication, 1721
Ingestion of Ethanol Increase in the γ-Aminobutyric Acid Content of Rat Brain after (Dr H-M Hakkinen and E Kulonen), 726
Ingle, H D, and others Transport of Driftwood from South America to Tasmania and Macquarie Island, 203
Ingles, Dr T A, and Popper, P Special Ceramics (Preparation of Boron Nitride), 1116
Inglis, Dr W G Plant Nematodes, *review*, 1349
Ingold, Sir Christopher Substitution at Elements other than Carbon (Fifth Weizmann Memorial Lecture), *review* by Dr R I Reed, 1262
Ingram, Dr D J E Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
  Appointed to the chair of physics in the University College of North Staffordshire, 410, 590, work of, 590
  Free Radicals as Studied by Electron Spin Resonance, *review* by Dr T M Sugden, 1259
Ingram, Dr D J E, and others Free Radicals in X-Rayed Seeds of High and Low Water Content, as Measured by Electron Spin Resonance, 464
  Electron Spin Resonance Investigations of *Allium cepa* and *Calliphora vomitoria*, 1402
Ingram, M Biological Effects of Low Doses of Ionizing Radiations, 1112
Ingram, Dr V M (Hunt, Dr J A, and) A Terminal Peptide Sequence of Human Haemoglobin?, 640
  Human Haemoglobin *E*—the Chemical Effect of Gene Mutation (Abnormal Human Haemoglobins), 870
Ingram, Dr V M, and Stretton, A O W Genetic Basis of the Thalassaemia Diseases, 1903
Inhalation (Sulphur Dioxide) Influence of, on the Phagocytic Activity of the Macrophage System (Prof D L J Bilbey and Dr H Salem), 722
Inheritance Cytoplasmic (Prof D G Catcheside), 1012
Inheritance of Haemoglobin by Asymmetric Recombination Properties and (Dr Harvey A Itano and Elizabeth Robinson), 1468
Inhibiting the Oxidation of Ascorbic Acid Presence in Rose Hips of Substances (Dr G A D Jackson and R B Wood), 902
Inhibiting Effect of Iproniazid on the Depletion of Adrenal Catechol Amines induced by Reserpine Abolition by Chlorpromazine of the (F Camanni, Dr G M Molinatti and M Olivetti), B A 65
Inhibition of Actinomycin Synthesis by D-Valine (Prof Edward Katz), 1666
Inhibition of Adrenaline Metabolism Activation and (Dr Julius Axelrod and Dr Robert Tomchick), 2027
Inhibition of the Arylesterase of Human Serum Activation and (Prof E G Erdos, C R Debay and M P Westerman), 430
Inhibition by Azide Measurement of, in Biochemical Assay Systems involving Nitrite Estimation by Diazotization (Dr E J Hewitt and D G Hallas), 1483
Inhibition of Liver Hexokinase by Dehydroascorbic Acid and Alloxan (Dr S K Bhattacharya), 1638
Inhibition of Reduced Diphosphopyridine Nucleotide Oxidation by Ammonia (R T Wedding and H M Vines), 1226
Inhibition of Rous I Sarcoma Metastases by a Copper-Catalyst Blocking Agent (Dr B M Jones), 1963
Inhibition of Skeletal Formation in the Chick Embryo following Administration of Tetracycline (Gerrit Bevelander, Hiroshi Nakahara and Gloria K Rolle), 728
Inhibition by Thyroxine of Oxidative Phosphorylation in Guinea Pig Heart Sarcosomes Reversal by Acetylcholine of the (Heitor Medina and Metry Bacila), 1066
Inhibition of Tumour Growth with 2 5-Dicarbethoxy-3 4-Dihydroxy-Thiophene (Dr M B Sahasrabudhe, M V Narurkar, L B Kotnis, B D Tilak and M D Bhavsar), 201
Inhibition of Urease by Alloxan and Alloxanic Acid (Dr Clarke T Gray, Marcus S Brooke and John C Gerhart), 1936
Inhibition (8-Azaguanine), of Haemoglobin Synthesis in De-embryonated Chick Blastoderm (B R A O'Brien), 376
Inhibition (Corticosterone), of Pyridine Nucleotide Oxidase from Heart Sarcosomes (P K Jensen), 451
Inhibition (Enzyme) Prevention of Foetal Development by (Prof G Kahlson and Elsa Rosengren), 1238
Inhibition (Esterase), and Organophosphorus Poisoning in the House-Fly (Dr D Stegwee), 1253
Inhibition (Growth), of Mouse Ascites Tumour Cells by Powdered Tragacanth (Tragacanthae Pulvis, B P), (Dr E M F Roe), 1891
Inhibition (Reflex), of Intestinal Motility (Nils G Kock) 1069
Inhibition (Selective) of Ribonucleic Acid Synthesis in *Staphylococcus aureus* by Vancomycin (Prof D C Jordan and W E Inniss), 1894
Inhibition (Specific), of Antibody Formation during Immunological Paralysis and Unresponsiveness (Dr E Sercarz and Dr A H Coons), 1080
Inhibition (Specific), of Anti-Rh Serum by 'Unnatural' Sugars (Dr William C Boyd, Marjorie H McMaster and Eugenia Waszczenko-Zacharczenko), 989
Inhibition (Staphlocoagulase), by Pooled Human Gamma-Globulin (Prof Murray M Streitfeld, Prof Bennett Sallman and Seymour M Shoelson), 1665
Inhibition (X-Ray Induced), of Deoxyribonucleic Acid Synthesis in *Escherichia coli* 15_T Influence of Unbalanced Growth on subsequent (Daniel Billen), 174
Inhibitor of Cytochrome Oxidase Activity in the Sea Urchin Egg (Rachele Maggio and Alberto Monroy), 68
Inhibitor-β Action of, on the Growth of *Striga* Seedlings (C N Williams), 1577
Inhibitor (Arginase) Uraemia and its Treatment by (Dhruba K Sen), 459
Inhibitor (A New), of Serotonin Metabolism (Dr Alfred R Maass and Mary Jane Nimmo), 547
Inhibitor (A Non-Dialysable), of Glutamo-Transferase present in Excised Tomato Roots (C S Vaidyanathan and Prof H E Street), 347
Inhibitor (Plant-Virus), from Rice Chemical Nature of a (W A Jones, M Jacobson and R P Kahn), 1146
Inhibitors (Serum), of Asian Strains of Influenza Virus (Suzanne M James and Paul Fiset), 1656
Inhibitory Effect of Fungistatic Antibiotics on the Production of Amylase by *Penicillium chrysogenum* (Dr I Horvath and A Szentirmai), 57
Initiation of Flowers and Runners in the Strawberry Effect of Gibberellic Acid on the (P A Thompson and C G Guttridge), B A 72
Initiation (Floral), and its Relationship to Growth Stage in Red Clover (*Trifolium pratense* L), (J L Stoddart), 559
Injected Dextran Labelled with Tritium in Mice Fate of (Å Hanngren, E Hanson, S Ullberg and Prof B Åberg), 373
Injected Mouse Blood Abrogation by, of Protective Effect of Foreign Bone Marrow in Lethally X-Irradiated Mice (L J Cole and R M Garver), 1815
Injection of Onchospheres Infection of Cattle with *Cysticercus bovis* by the (G Froyd and M C Round), 1510
Injection (Intravenous), of Newborn Rats and Mice An Improved Technique for (N F Anderson, E J Delorme, Prof M F A Woodruff and D C Simpson), 1952
Injured Cellular Blood Elements in Extracorporeal Circuits Release of Adenosine Triphosphate and Serotonin from (Dr H S S Sarajas, Dr R Kristoffersson and Dr M H Frick), 1127
Injury (Radiation), in Mice Prophylactic Effects of Amine Oxides in (Dr Thomas J Haley, Dr Anna M Flesher and Dr Nathan Komesu), 198
Inland Telegraphy Service, Advisory Committee on the Report of the, 1191
Inland Waterways in Britain, 1687
Inner Auroral Zone Existence of an (Dr Knud Lassen), 1375
Inner Solar Corona during June 1959 (G A Newkirk, G W Curtis, D K Watson, R Manning and J Shelby), 1308
Innervated Sweat Glands (Cholinergically) Response of, to Adrenaline and Noradrenaline (Dr David P C Lloyd), 277

Innes (John) Horticultural Institution Forty-ninth Annual Report (1958), 1036
Inniss, W E (Jordan, Prof D C , and) Selective Inhibition of Ribonucleic Acid Synthesis in *Staphylococcua aureus* by Vancomycin, 1894
Innovation Investment in (C F Carter and B R Williams), *review* by Prof A J Brown, 1348
Inorganic Chemistry, Russian Journal of (A translation of the Russian *Zhurnal Neorganicheskoi Khimii*, published by the Chemical Society), 319
Inorganic Chemistry Modern, *review* by Dr D W A Sharp, 1756
Inorganic Chemistry and Radiochemistry Advances in (edited by H J Emeleus and A G Sharpe), Vol 1, *review* by Dr D W A Sharp, 1756
Inorganic Phosphate Need for, in Oxidations stimulated by Dinitrophenol (P Borst and Prof E C Slater), 1396
Inositol Concentration in the Cerebrospinal and Ocular Fluids and Tissues of the Foetal and Adult Sheep (D A Nixon), 906
Inotropic Activity (Positive), of Cytidine Triphosphate (Winifred G Nayler and Marian McCulloch), 67
Insect Survival of Frozen Fat Body Cells in an (R W Salt), 1426
Insect attacking *Striga* An (C N Williams and G H Caswell), 1668
Insect Pests of Cotton in Tropical Africa (E O Pearson, assisted by R C Maxwell Darling), *review* by Dr W E China, 1011
Insect Polyphenoloxidase Interaction between Thiourea and (Wanda Chmurzynska and Lech Wojtczak), 1941
Insecticidal Action of Ethylene *Bis*dithiocarbamates (R D McMullen), 1338
Insecticidal Effects of Activated Charcoal and Clays (S K Majumder, K S Narasimhan and V Subrahmanyan), 1165
Insecticide Dieldrin Mechanisms of Resistance of Adult Houseflies to the (F P W Winteringham and A Harrison), 608
Insecticide and Nematicide Formulations (Soil) Effect of Emulsifiers and Organic Diluents in (F T Phillips), 1512
Insecticides Effect of, on the Bodies of Nissl and Neurofibrillae of the Locust, *Schistocerca gregaria* (Dr Tohamy A Moussa and M Banhawy), 915
  New Pests of Cocoa (*Theobroma cacao* L) in Ghana following Applications of (P F Entwistle, C G Johnson and E Dunn), 2040
Insectivore Transmission of Passive Immunity in an (B Morris), 1151
Insects Possible Role of Glycerol in the Winter-Hardiness of (P Dubach, D Pratt, Prof F Smith and C M Stewart), 288
  Prothoracic Gland Stimulation by Juvenile Hormone Extracts of (Dr Lawrence I Gilbert and Dr Howard A Schneiderman), 171
  Secretion of Wax through the Cuticle of (Dr M Locke), 1967
  Sectioning Large Heavily Sclerotized Whole (Prof W E Beckel), 1584
Insects in the Garden (Educational Productions, Ltd , Filmstrip No 5260), 1777
Insects (Individual) The Infra-Red Gas Analyser as a Means of Measuring the Carbon Dioxide Output of (Dr A G Hamilton), 367
Insects (Lepidopterous) Relationship between Larval and Pupal Periods of some (Dr M A Zaher and Dr Moufied A Moussa), 288
Inside the Living Cell (Dr J A V Butler), *review* by Dr W L Sumner, 134
Inskeep, R R Khami Ruins, *review*, 1349
Insoluble Anhydrite Transition of Calcium Sulphate Hemihydrate to (Chikara Mitsuki and Masayoshi Kita), 1481
Insoluble Protein-Tannin Compounds Regeneration of Protein from (Dr W Mejbaum-Katzenellenbogen, W Dobryszycka, J Boguslawska-Jaworska and B Morawiecka), 1799
Institut pour la Recherche Scientifique en Afrique Centrale Dixième Rapport Annuel (1957), 407
Institut National pour l'Étude Agronomique du Congo Belge Carte des Sols et de la Vegetation du Congo Belge et du Ruanda-Urundi, 6, Yangambi, Planchette 3, Lilanda, A, Sols, B, Vegetation (Notice explicative par P Gilson, P Jongen, A Van Wambeke et L Liben), 27
  Publications, Série Scientifique No 75, Moisissures du Sol et des Litieres de la Region de Yangambi (L Meyer), 236
  Publications, Série scientifique No 77, Recherches sur les Affinités Chromosomiques dans le Genre *Coffea* (J Bouharmont), 518
  Publications, Série Scientifique No 78, Recherches sur l'Autostérilité du Caféier robusta (*Coffea canephora* Pierre), (M Devreux, G Vallaeys, P Pochet et A Gilles), 518
Institut Royal Meteorologique de Belgique Publications Serie A, No 7, Realisation du Centre de Physique du Globe à Dourbes (Prof E Lahaye), 1022
Institut Royal des Sciences Naturelles de Belgique Memoire 143, Foraminifera of the Oligocene of Belgium (D A J Batjes), 321
Instructional Film Research in Pennsylvania (C Denis Pegge), 866
Instrument Construction English translation of the Russian journal *Priborostroenie*, No 1 (British Scientific Instrument Research Association), 592
Instrument Symposium and Research Equipment Exhibit Ninth Annual (United States National Institutes of Health), 26
Instrumentation of Reactors Third Reactor School Course on the Control and (Atomic Energy Research Establishment), 1026
Instrumentation Engineers Differential Equations for, *review* by Prof T A A Broadbent, 6
Insulating Oil Gaps Luminous Spots on Electrodes in (T W Dakin and Daniel Berg), 120
Insulating Particles on Cathode Surfaces—their Effect upon Electrical Discharges (L B Griffiths and P C L Pfeil), 1475
Insulin Combined Effects of Cortisone and, on Developing Chicken Embryos (Dr Pietro de Franciscis and Prof Walter Landauer), 101
  Passage of, through the Wall of the Gastro-intestinal Tract of the Infant Rat (Dr B Mosinger, Z Placer and O Koldovsky), 1245
Insulin (Plasma), in Human Subjects Assay of, by Immunological Methods (Dr Rosalyn S Yalow and Dr Solomon A Bersen), 1648
Insulin Resistance of Fasted Rats Effect of Whole-body X-Irradiation on the (Dr V Stanković and N Sestan), 1816
Insulin-Sensitivity of the Rat Diaphragm *in vitro* Role of Magnesium in the (Dr Gangagobinda Bhattacharya), 1401
Insulin-like Activity (Increased Circulating), in Obese-Hyperglycaemic Mice (Jean Christophe, Yves Dagenais and Jean Mayer), 61
Insulin and Hypersensitivity (R K Sanyal, P S J Spencer and Dr G B West), 2020
Intact Ascites Tumour Cells Efficiency of the Mitochondrial Oxidative Phosphorylations in (Dr P Emmelot and C J Bos), 2024
Intact Mouse Spleen Decrease in Radiosensitivity of the, produced by Hypoxia (Dr L Weiss), 1156
Intake (Herbage), of Grazing Cattle A Relationship between Weight of Internal Fat, 'Fill', and the (J C Tayler), 2021
Intake (Sodium Chloride), and Urinary Histamine in Adrenalectomized Rats (Dr T Bjuro and Dr H Westling), 1241
Integral Modern Theory of the, *review*, 574
Integration An Introduction to the Theory of (Prof Adriaan C Zaanen), *review*, 574
Intensity associated with the Cosmic-Ray Storm of February 11, 1958 North–South Anisotropy and Anticipatory Increase of (Dr V Sarabhai and R Palmeira), 1204
Intensity of Infra-red Absorption Bands—a Bibliography (compiled by Dr R G Gillis), 682
Intensity of the (111) Reflexion for Diamond (Prof R Brill and H Barth), 264
Intensity of the Umbra of Sunspots and Enhanced Radiation on 200 Mc /s Correlation between the (Per Maltby), 1391
Intensity (Geomagnetic Vertical), around the Magnetic Equator Possible Asymmetry in the Daily Range of the (Dr C A Onqumechilli), 51
Interaction between the Agglutinating Sera and the Corresponding Red Blood Cell Receptors Influence of Streptomycin Solutions on the (Dr M Kout and Dr Z Kubickova), 639
Interaction of Anti-Staling Agents with Starch (Prof E J Bourne, A I Tiffin and Dr H Weigel), 547
Interaction of Deoxyribonucleate and Magnesium Ions Determination of the, by means of a Metal Ion Indicator (Joseph Shack and Barbara S Bynum), 635
Interaction of Erythrocytes and Endotoxins (V Bokkenheuser and H J Koornhof), 109
Interaction between Nucleic Acid and a Cationic Detergent (Prof Dino Guerritore and Luciano Bellelli), 1638
Interaction of Plant Growth Regulators in Regeneration Processes (H Schraudolf and Prof J Reinert), 465
Interaction of Streptomycin and Dihydrostreptomycin with Apo- and Co-dehydrogenases (Prof K Michalska), 987
Interaction of Sucrose Stearate with Starch (Prof E J Bourne, A I Tiffin and Dr H Weigel), 110
Interaction between Thiourea and Insect Polyphenoloxidase (Wanda Chmurzynska and Lech Wojtczak), 1941
Interaction (Electron–Phonon), in Solids (Physical Society Conference on), 1613
Interaction (Exchange), as a Cause of Reverse Thermo-Remanent Magnetism (T Nagata and S Uyeda), 890
Interactions between Behaviour Patterns in a Hemileucine Moth Central Control of (Dr A D Blest), 1164
Interactions (Anomalous Genetic), observed in *Bacillus subtilis* (M Kohiyama and Y Ikeda), 208
Interactions (Paraffin-Detergent), in Aqueous Systems Solid State Rheological Study of the Mechanism of (F J Radd and L H Crowder), 443
Interchange Energy for Binary Systems Estimation of the, from Mutual Solubility Data (Kiyoharu Ishida), 814
Interfacial Disturbances in Gas–Liquid Systems Droplet Circulation and (Dr C Ramshaw and Dr J D Thornton), 719
Interfacial Micro-Windows Wear Observations through (Robert H Savage), 45
Interference by Azide with Diazotization Procedures used in Biological Assay Systems (J R Villanueva), 549
Interference Distances (Differential and), of Chiasmata Simultaneous Change in both (Dr J Yanney Wilson), 207
Interfering Substances in the Determination of Glucosamine Synthesis (Dr Fiorenzo Paronetto), 1317
Interferometry (Beam) Substrate Damage in Film Thickness Measurement by (Prof G David Scott), 354
Interferon Duration of Protective Action of, against Infection with West Nile Virus (Dr Alick Isaacs and Marguerite A Westwood), 1232
Interferon produced by Cultures of Calf Kidney Cells (Dr D A J Tyrrell), 452
Intergranular Diffusion in a Silicate System Measurement of—Iron in Forsterite (Prof John J Naughton and Yasuo Fujikawa), B A 54
Interlamellar Films Phase Transitions in (Dr D M C MacEwan and Dr F Aragón de la Cruz), 1859
Intermediate Metabolite (Possible), of Benzene Hexachloride in Houseflies Pentachlorocyclohexene as a (R G Bridges), 1337
Intermediates in the Hydrolysis of *p* Nitrophenyl Acetate Catalysed by Chymotrypsin Reactivity and Interrelationship of (Mario A Marini and Prof George P Hess), 113
Intermolecular Distances and Diamagnetic Anisotropy in Crystals as Measures of the Polarity of Benzene and Borazole Substituents (Dame Kathleen Lonsdale), 1060
Internal Fat, 'Fill', and the Herbage Intake of Grazing Cattle A Relationship between Weight of (J C Tayler), 2021
Internal Reproductive Rhythm in a Xerophilous Equatorial Bird, *Quelea quelea* Duration of the Regeneration Period of the (H J de S Disney, B Lofts and Dr A J Marshall), 1659
Internal Rhythm of Reproduction in a Trans-Equatorial Migrant (the Short-tailed Shearwater *Puffinus tenuirostris*) Experimental Demonstration of an (Dr A J Marshall and Dr D L Serventy), 1704
Internal Vibrations (Rigid-Body and), of Organic Molecules An X-Ray Study of (Dame Kathleen Lonsdale and Dr H Judith Milledge), 1545
Internal and the External Worlds (Sir Cyril Hinshelwood), 1834
International Association of Scientific Hydrology Symposium on the Effects of Forest Areas on Water Resources, 1184
  Symposium on the Technique of Lysimetry, 1184
International Atomic Energy Agency Directory of Nuclear Reactors, Vol 1, Power Reactors, *review* by Dr A J Salmon, 1438
International Atomic Energy Agency and the International Council of Scientific Unions Symposium on Radioactivation Analysis, 951
International Atomic Energy Agency (Unesco and the) Appeal for help to reconstruct the Library of the Brazilian Centre for Physics Research, 769
International Atomic Energy Agency, and others Symposium on the Biological Effects of Low Doses of Ionizing Radiations, 1111
  Course on the Use of Radioisotopes in Agricultural Research, 1451
International Botanical Congress Montreal Ninth, 1200
International Business Machines Corporation Appointment of Dr Carl F Kossack as manager of the newly formed Statistics and Operations Research Department at the Lamb Estate Research Center, Cortlandt, N Y , 410

International Centre for the Study of the Preservation and Restoration of Cultural Property Inauguration of the, 504
  Appointment of Dr H J Plenderleith as first director, 504
International Commission on Higher Education in Nigeria Inaugural Meeting, 152
International Commission on Zoological Nomenclature Given accommodation in the British Museum (Natural History), 156
International Conference on Coal Science Third Biennial, 412
International Conference on Ionization Phenomena in Gases Fourth, 1353
International Conference on Medical Electronics Third (Electronics and Communications Section of the Institution of Electrical Engineers and the International Federation for Medical Electronics), 1535
International Conference on Non-Destructive Testing, 1107
International Conference on Nuclear Forces and the Few-Nucleon Problem, 1113
International Conference on Plant Growth Regulation Fourth (Boyce Thompson Institute for Plant Research, the New York Botanical Garden and the Brooklyn Botanic Garden), 599
International Conference of Radio Astronomers, *review* by Dr H P Palmer, 1755
International Conference of Scientists Pugwash—Statement on Biological and Chemical Warfare, 1018
International Conference on Semi-Conductors Proceedings of the Third, Rochester, 1958 (Advances in Semi-Conductor Science, edited by H Brooks), *review* by Dr J R Tillman, 1674
International Conference on the Use of Solar Energy Transactions of the —The Scientific Basis (Tucson, 1955) , Vol 1, The Available Energy, Measurement of Radiation , Vol 2, Thermal Processes, Part 1, Section A, Flat Plate Collectors , Vol 2, Thermal Processes, Part 1, Section B High-Temperature Solar Furnaces, Solar Power , Vol 3, Thermal Processes, Part 2, Solar House Heating, Solar Water Heating, Solar Stoves, Solar Distillation , Vol 4, Photochemical Processes , Vol 5, Electrical Processes, *review* by Dr H Heywood, 217
International Congress on Acoustics (Prof E G Richardson), 1031
International Congress on Chagas's Disease (Dr J D Fulton), 1114
International Congress of Refrigeration Tenth (International Institute of Refrigeration), 946
International Convention on Transistors and Associated Semiconductor Devices (Electronics and Communications Section of the Institution of Electrical Engineers), 693
International Council for the Exploration of the Sea Special International Geophysical Year Meeting (A J Lee and Dr D H Cushing), 1180
International Council of Museums Fifth General Conference (Museums as Mirrors—their Potentialities and Limitations), 504
  Inauguration of an International Centre for the Study of the Preservation and Restoration of Cultural Property, 504
International Council of Scientific Unions Yearbook 1959, 408
  International Council of Scientific Unions Review, No 1, 319 , No 2, 408
  Financial Statement for November 1957 to December 1958, 939
International Council of Scientific Unions (International Atomic Energy Agency and the) Symposium on Radioactivation Analysis, 951
International Cytology, *review* by Prof J Bronte Gatenby, 574
International Federation of Automatic Control Members of the Executive Council, 1450
International Federation for Medical Electronics (Electronics and Communications Section of the Institution of Electrical Engineers and the) Third International Conference on Medical Electronics, 1535
International Geophysical Year Annals of the, Vol 6, Manual on Rockets and Satellites (edited by L V Berkner, in association with John Hanessian, Jr , and Leonard Cormier), *review*, 213
  Photography in the (Scientific and Technical Group of the Royal Photographic Society Symposium on), 1032
  Some Achievements (Royal Society), 604
International Institute of Refrigeration Tenth International Congress of Refrigeration, 946
International Mineralogical Association First General Meeting (Prof Robert L Parker), 1909
  Symposium on Alpine Mineral Fissures, 1909
  Symposium on Twinning of Crystals, 1910
International Nickel Company of Canada Ltd Establishment of a Fellowship to honour the visit of H M the Queen and H R H the Duke of Edinburgh, 772
International Oceanographic Congress (Dr G E R Deacon), 1605
International Organizations of Medical Sciences Abnormal Haemoglobins —a Symposium organized by the Council for (edited by J H P Jonxis and J F Delafresnaye), *review* by Dr J A M Ager, 840
International Potash Institute Sixteen Papers read at the Fourth Congress of the (Vienna, 1957), *review*, 1976
International Red Locust Control Service Work of the, 589
  Retirement of Dr D L Gunn from the directorship, 589
  Appointment of C du Plessis as director, 590
International Review of Cytology (edited by Prof G H Bourne and Prof J F Danielli), Vol 7, *review* by Prof J Bronte Gatenby, 574
International Scientific Relationships, Society for Promoting Special Medal awarded to Dr Detlev W Bronk, 1685
International Society for Plant Geography and Ecology International Symposium on Mapping Vegetation, B A 23
International Standards Organization First Meeting of Technical Committee No 93, 514
International Symposium on the Ageing of Plastics (Eighth German Plastics Convention), 508
International Symposium on Algology (Indian Council of Agricultural Research and Unesco), 595
International Symposium on Combustion Report of the Seventh, 770
International Symposium on Enzyme Chemistry Proceedings of the (Tokyo and Kyoto, 1957), (Science Council of Japan, under the auspices of the International Union of Biochemistry), *review* by Dr J B Chappell, 388
International Symposium on Macromolecules (Commission on Macromolecules of the International Union of Pure and Applied Chemistry), 1689
International Symposium on X-Ray Microscopy and X-Ray Microanalysis, 860
International Technical Co-operation Partnership for Progress—(Annals of the American Academy of Political and Social Science, May, 1959), *review* by R Brightman, 1673
International Union of Biochemistry (organized by the Science Council of Japan under the auspices of the) Proceedings of the International Symposium on Enzyme Chemistry (Tokyo and Kyoto, 1957), *review* by Dr J B Chappell, 388
International Union of Pure and Applied Chemistry Meeting of the Commission on Geochemistry, 1193
  Election of members of the Commission on Geochemistry, 1193
  Election of Prof C W Correns as president for 1960 of the Commission on Geochemistry, 1193
International Union of Pure and Applied Chemistry (Committee of the Analytical Chemistry Section) Nomenclature in Titrimetric Analysis, 1686
International Union of Pure and Applied Chemistry (Commission on Macromolecules) International Symposium on Macromolecules, 1689
International Union of Pure and Applied Chemistry (Deutsche Bunsengesellschaft fur Physikalische Chemie and the) Symposium on Thermodynamics, 1606
International Veterinary Congress (Dr M A Soltys), 598
Interocular Transfer Some New Subjective Phenomena apparently due to (Ian P Howard), 1516
Interpeduncular and Dorsal Tegmental Nuclei A Heat-Loss Mechanism involving the Habenular, (B G Cragg), 1724
Interpretation (A Functional), of the Electron-Microscopic Structure of the Sensory Hairs in the Cristae of the Elasmobranch *Raja clavata* in Terms of Directional Sensitivity (Prof O Lowenstein and J Wersäll), 1807
Interrelations between the Blood Coagulating System and the Physiological Anticoagulating System (Prof P A Kudrjashov), 454
Interrelations (Carbohydrate—Amino-Acid), in Brain Cortex *in vitro* (M M Kini and Prof J H Quastel), 252
Interrelationship of Intermediates in the Hydrolysis of p-Nitrophenyl Acetate Catalysed by Chymotrypsin Reactivity and (Mario A Marini and Prof George P Hess), 113
Interruption (Night), with Red Light Complex Reaction in *Hyoscyamus niger* upon (P J A L de Lint), 731
Interspecific Hybrids of *Lycopersicum* (Helgi Nirk), 1819
Interspecific Pollination Production of Seedless Hops by (Prof Edward L Davis), 1336
Interstellar Communications Searching for (Giuseppe Cocconi and Philip Morrison), 844
Interstrain Ovarian Transplantation in Lethally Irradiated Mice after Bone Marrow Therapy (Prof W St Amand and L H Smith), 1503
Inter-University Geological Congress Eighth, 1914
Intestinal Motility Reflex Inhibition of (Nils G Kock), 1069
Intestine of Rats Pharmacological Suppression of Increased Capillary Permeability following Irradiation of the (Dr D A Willoughby), 1156
Intestine (Large), of the Calf Absorption of Magnesium in the (Dr R H Smith), 821
Intoxication (Auto-) apres Brûlure (R Godfraind), *review* by Dr S Sevitt, 5
Intoxication (Experimental Diphtheric) Effect of Tranquillizing Drugs on Survival from (Prof Leo Greenberg and Dr James W Ingalls), 1721
Intracardiac Blood Velocity Patterns Intravascular and, recorded by means of *NTC* Resistors (Dr W G Zijlstra, J R Brunsting and L B v d Slikke), 991
Intracellular Activities of Sodium and Potassium Glass Micro-Electrodes for Measuring (Dr J A M Hinke), 1257
Intracellular Thioctic Acid and Coenzyme A following Vanadium Treatment (E Mascitelli-Coriandoli and Dr C Citterio), 1641
Intraperitoneal Infections of Mice Opsonins as Determinants of Survival in (Dr C R Jenkin and Prof D Rowley), 474
Intraspecific Polyploidy and Evolution of Diverse Morphological Forms in *Convulvulus pluricaulis* Chois (Dr S L Tandon and C P Mzalik), 481
Intravascular and Intracardiac Blood Velocity Patterns recorded by means of *NTC* Resistors (Dr W G Zijlstra, J R Brunsting and L B v d Slikke), 991
Intravenous Administration to Rats Presence of certain Onium Compounds in Brain Tissue following (Prof Ruth R Levine), 1412
Intravenous Injection of Newborn Rats and Mice An Improved Technique for (N F Anderson, E J Delorme, Prof M F A Woodruff and D C Simpson), 1952
Intravenously Administered Lactose Labelled with Carbon-14 Preliminary Observations on the Fate of (Dr Frederick J Carleton and Dr Henry R Roberts), 1650
Introduction (A New), to Geology, *review* by Dr J C M Taylor, 1175
Intrusions (Dolerite), from the Theron Mountains and Whichaway Nunataks, Antarctica Palaeomagnetism of some (D J Blundell and P J Stephenson) 1860
Invasive Capacity Relation of, to Passage of Lymphocytic Cells through Cellulose Membrane Filters (Dr Emma Shelton and Dr Mary E Rice), 479
Invertebrate Morphology Studies in—in honor of Dr Robert Evans Snodgrass on the occasion of his eighty-fourth Birthday (Smithsonian Institution, Miscellaneous Collections Vol 137), 591
Invertebrates The (Dr Libbie Henrietta Hyman), Vol 5, Smaller Coelomate Groups—Chaetognatha, Hemichordata, Pogonophora, Phoronida, Ectoprocta, Brachipoda, Sipunculida, the Coelomate Bilateria, *review* by Dr N B Eales, 573
Inverted Plots Non-Inverted versus, in Enzyme Kinetics (Dr B H J Hofstee), 1296 , (Dr Malcolm Dixon and Dr Edwin C Webb), 1298
Investigation (*in vitro*) of the Colloid-storing Function of Histiocytes A Method for (Prof N Jancsó, Aurelia Jancso-Gabor and J Balassy), 1070
Investigations (Electron Spin Resonance), of *Allium cepa* and *Calliphora vomitoria* (M Edwards, Dr G A Kerkut, K A Munday, Dr D. J Ingram, M C Saxena and K Leach), 1402
Investigations (Preliminary Archaeological), in the Sierra de Tamaulipas, Mexico (Dr Richard S MacNeish), 593
Investment in Innovation (C F Carter and B R Williams), *review* by Prof A J Brown, 1348
Iodine (Radioactive) Affinity of Lysozyme with Structural Elements of the Bacterial Cell as studied with Enzyme Labelled with (Prof C Weibull, B Zacharias and H Beckman), 1744

Iodine (Radioactive), in Thyroid Glands Accumulation of, subsequent to Nuclear Weapon Tests and the Accident at Windscale (Dr Hamish A Robertson and Ian R Falconer), 1699
Iodine-131 Distribution in the Mouse of Lethal and Sub-Lethal Doses of Cottonmouth Moccasin Venom labelled with (Prof J F Gennaro, jun , and H W Ramsey), 1244
  Labelling of Rose Bengal with, by Radioactive Exchange (J Liebster and O Andrysek), 913
  Paper Chromatographic Separation of Components of Rose Bengal Labelled with (Fausto W Lima and Rômulo R Pieroni), 1065
Ion (Alkali) Determinations by means of Glass Electrodes (Research Symposium at the University of Sheffield), 1616
Ion (Bromide) A Peripheral Effect of the, on the Contraction of Striated Muscle (Dr D K de Jongh and H A Linnewiel) 1240
Ion ($FeS_2O_3^+$) Reduction of the, at the Dropping Mercury Electrode (F M Page), 1481
Ion (Tropylium) Isomerization to the, induced by Electron Impact and its Significance (Dr W Hanuš), 1796
Ion Exchange, *review* by D Reichenberg, 1757
Ion Exchange, a Laboratory Manual (Dr J E Salmon and D K Hale), *review* by D Reichenberg, 1757
Ion Exchange Resins (Robert Kunin), second edition, *review* by D Reichenberg, 1757
Ion Flotation Concentration by (Prof F Sebba), 1062
Ion Indicator (Metal) Determination of the Interaction of Deoxyribonucleate and Magnesium Ions by means of a (Joseph Shack and Barbara S Bynum), 635
Ionic Current Effects of the Energy of Strong Pulses of, on Micro-organisms in Suspension (B S Gossling), 1881
Ionic Partition and Fine Structure in Muscle (Dr Shirley E Simon), 1978
Ionization (*E*) A Relation between Giant Travelling Disturbances and Sporadic (L H Heisler), 1788
Ionization Phenomena in Gases (J Dutton, D Harcombe and E Jones), 1353
Ionization Type Detector (Radioactive) Analysis of Permanent Gases by Gas Chromatography using a (V Willis), 894
Ionized Calcium in Biological Media (Prof J Ettori and Sybil M Scoggan), 1315
Ionizing Radiation Cross-linking of Cellulose Acetate by (Dr S H Pinner, T T Greenwood and D G Lloyd), 1303
  A 'Progressive' Mutation induced in *Poa pratensis* L by (A A Hanson and F V Juska), 1000
  A Sensitive Chemical Dosimeter for (Prof Gerald Oster and Dr Barret Broyde), 545
Ionizing Radiations Advice concerning Hazards from (Ministry of Housing and Local Government, Circular No 57/59), 1450
  Biological Effects of Low Doses of (Unesco, the International Atomic Energy Agency and the Comitato Nazionale per le Ricerche Nucleari Symposium on), 1111
  Cross-Linking of Deoxyribonucleic Acid in Sperm Heads by (Dr P Alexander and Dr K A Stacey), 958
  Degradation of Thiotaurine by (D Cavallini, B Mondovì, B Giovanella and C De Marco), B A 61
  Disorganization of the Secondary Structure in Proteins exposed to, in the Solid State (Dr Peter Alexander, L D G Hamilton and Dr K A Stacey), 226
  Immediate and Low-level Effects of (Dr Tikvah Alper), 1111
  Waterways and, 1450
Ionosphere The *D* Region of the (B Bjelland, O Holt, B Landmark and F Lied), 973
  Measurement of Cosmic Noise at Low Frequencies above the (J P I Tyas, C A Franklin and A R Molozzi), 785
  Recent Trends in the Theory of the (J A Ratcliffe), 419
  Two Anomalies in the Behaviour of the *F2* Layer of the (Sheila Croom, Audrey Robbins and J O Thomas), 2003
  Very Low-Frequency Spectra of Atmospherics propagated through the (Tatsuzo Obayashi), 34
Ionospheric *F*-Region Disturbance in the, following the Johnston Island Nuclear Explosion (C H Cummack and G A M King), B A 32
Ionospheric Layer (F_2) Tides in the (Dr P Herrinck), 1055
Ionospheric Heights Refraction of Very High Frequency Radio Signals at (S Weisbrod and L Colin), 119
Ionospheric Phenomena (Geomagnetic and), associated with Nuclear Explosions (Dr S Matsushita), B A 33
Ionospheric Virtual Height-Frequency Curves Conversion of, to Electron Density-Height Profiles (Dr J O Thomas and M D Vickers), (Radio Research Board, Special Report No 28), 1024
Ions (Calcium), and the Permeability of Human Red Cells (Prof M Maizels), 366
Ions (Co^{++}) Temperature Variation of the Principal Magnetic Moments of, and the Asymmetry of the Crystalline Electric Field in Cobalt Acetate Tetrahydrate (Dr Bhagawati Charan Guha), 50
Ions (Magnesium) Determination of the Interaction of Deoxyribonucleate and, by means of a Metal Ion Indicator (Joseph Shack and Barbara S Bynum), 635
Ions (Metal) Fungitoxicity of (Dr E Somers), 475
Ions (Relatively High-Energy) Emission of, from Low-Voltage Arcs (E R Harrison), 245
Iproniazid Abolition by Chlorpromazine of the Inhibiting Effect of, on the Depletion of Adrenal Catechol Amines induced by Reserpine (F Camanni Dr G M Molinatti and M Olivetti), B A 65
Iranians Glutathione Stability of the Erythrocytes in (Dr D G Walker and Dr J E Bowman), 1325
Ireland (Great Britain and) Handbook of the Rubi of (the late W C R Watson) *review* by R D Meikle, 489
Ireland (Northern) Statistics of Public (Rate Supported) Libraries in Great Britain and, 1957-1958 (Library Association), 592
Iris of the Eye Association between Colour of the, and Reaction to Dental Pain (Dr Philip R N Sutton), 122
Irish Late-Glacial *Lepidurus arcticus* in the (Dr M E S Morrison), 739
Iron in Culture Medium Estimation of μgm Quantities of, using Bathophenanthroline (P A Seamer), 636
Iron in the Forage A Lesion of the Follicle and of the Fibre of Wool and its Possible Relation with an Excess of (Prof G Gonzalez, J Garcia and E Fernandez), 559
Iron in Forsterite Measurement of Intergranular Diffusion in a Silicate System— (Prof John J Naughton and Yasuo Fujikawa), B A 54
Iron (Armco) Dynamic and Static Deformation of (H P Tardif and P Chollet), 1917
Iron-Binding Centre of Ferrichrome Compounds (Dr T Emery and Dr J B Neilands), 1632
Iron (III)–Cellulose Reaction-directing Properties of Non-enzymic Macromolecules—Pyrogallol Oxidation in the System (N S Goodman and S M Siegel), 53
Iron (Nonhaem), in Erythrocytes as a Precursor for Haemoglobin (Dr M Faber and Dr I Falbe-Hansen), 1043
Iron Meteorite Carbo' Calculation of a 'Cosmic Ray Age' for the (Dr Royal R Marshall), 117
Iron Transport Factors' An Absolute Requirement for, by *Microbacterium lacticum* 8181 (Dr D Hendlin and Dr A L Demain), 1894
Iron-Silicon Alloys A New Nitride Precipitate in (G R Booker and J Norbury), 1311
Iron-Silicon Alloys (Low-Carbon) X-Ray Diffraction Pattern of Carbide in (G Konoval, L Zwell, L A Gorman and W C Leslie), 1862
$FeS_2O_3^+$ Ion Reduction of the, at the Dropping Mercury Electrode (F M Page), 1481
Iron and Steel in China A History of, *review* by Prof F C Thompson, 1830
Iron and Steel Institute Meeting at the University of Birmingham and at Coalbrookdale, to celebrate the 250th anniversary of the successful use of coke in ironmaking, 322
  Sixth Report of the Corrosion Committee (compiled by Dr J C Hudson), 1023
  Autumn General Meeting 1192, 1451
Iron and Steel Research Association (British)—London Group Laboratories Open Days (D U Hunt), 1536
Iron and Steel Technology in China The Development of (Dr Joseph Needham), *review* by Prof F C Thompson, 1830
Iron and Zinc Effect of, on Nucleic Acid and Protein Synthesis in *Mycobacterium smegmatis* (Frank Winder and Joan M Denneny), 742
Ironmaking Successful Use of Coke in (Meeting of the Iron and Steel Institute at the University of Birmingham and at Coalbrookdale to celebrate the 250th anniversary of the), 322
Irradiated Lead Oxalate Thermal Decomposition of (P J Herley and E G Prout), 445
Irradiated Mice (Lethally) Interstrain Ovarian Transplantation in, after Bone Marrow Therapy (Prof W St Amand and L H Smith), 1503
Irradiated Solutions Aromatic Ring Opening in the Presence of Oxygen in (Israel Loeff and Gabriel Stein), 901
λ-Irradiated Polymethyl Methacrylate and Polymethacrylic Acid Electron Paramagnetic Resonance at 4 2° K of (Dr Derick W Ovenall), 181
γ-Irradiated Potato Starch Granules Physical and Chromatographical Observations of (Akira Mishina and Ziro Nikuni), 1867
Irradiation Increased Oxygen Consumption in Rats during (Dr A Vacek), 197
  Reorganization of Root Apices after (F A L Clowes), 1025
Irradiation of the Intestine of Rats Pharmacological Suppression of Increased Capillary Permeability following (Dr D A Willoughby), 1156
Irradiation of Nerve Effects of, on Muscular Response (A Portela, D Brandes, Prof G H Bourne, Marion Hines, P Stewart and B L. Redd, jun), 734
Irradiation (Ultra-Violet) Effect of, on Transduction in *Pseudomonas aeroginosa* (J S Loutit), 1960
  Photoautomerization of Cytosine Derivatives on (Shih Yi Wang), 184
  Production of a Perfect Stage in a Nutritionally Deficient Mutant of *Fusarium oxysporum* after (E W Buxton), 1258
Irradiation (Ultra-violet), of 1,3-Dimethylthymine (Shih Yi Wang), B A 59
γ-Irradiation Separation by, of Two Elements at the Vby Locus in *Trifolium repens* (Dr D Roy Davies and E T Wall), 1957
γ-Irradiation (Whole-Body) Cells which Synthesize Deoxyribonucleic Acid in Guinea Pig Bone Marrow during Recovery from (P F Harris and J H Kugler), 1883
Irradiations (X-Ray), in *Culex fatigans* Wied (1828) Induced Mutations of (R Pal and B S Krishnamurthy), 658
Irvine, Dr K J Appointed deputy research manager of the United Steel Companies, Ltd , 95
Irving, Prof J T Curative Effect of Selenium upon the Incisor Teeth of Rats deficient in Vitamin E, 645
Irving, Prof J T (Zar, L , and) Effect of Vitamin D on the Respiration of Rat Oral Tissue, 1410
Irzykiewicz, H (Powning, R F , and) A Reduced Triphosphopyridine Nucleotide-linked Cystine Reductase in the Clothes Moth, *Tineola bisselliella* (Humm), 1230
Is the Multimammate Rat a Natural Reservoir of *Borrelia duttoni* ? (Dr F Zumpt), 793
Isaacs, Dr A , and Lacey, B W (edited by) Virus Growth and Variation—Ninth Symposium of the Society for General Microbiology, London, 1959, *review* by N W Pirie, 920
Isaacs, Dr A , and Westwood, Marguerite A Duration of Protective Action of Interferon against Infection with West Nile Virus, 1232
Isaacson, E de St Q Rock Pressure in Mines, *review* by J K L Graham, 1349
Isaacson, Leonard M (Hiller, Jr , Prof L A , and) Experimental Music—Composition with an Electronic Computer, *review* by Prof E G Richardson, 1754
Isard, J O Alkali Ion Determinations by means of Glass Electrodes, 1616
Isatin β-thiosemicarbazone Antiviral Chemotherapeutic Activity of, in Mice infected with Rabbit-pox Virus (D J Bauer and F W Sheffield), 1496
Ishida, Kiyoharu Estimation of the Interchange Energy for Binary Systems from Mutual Solubility Data, 814
Ishidate, Prof Morizo, and others Incorporation of N-Methyl Carbon of Monoethylaminoazobenzene into Polar Dyes 1460
Isla de Pinos Variation in Lizards of the *Leiocephalus cubensis* Complex in Cuba and the (Albert Schwartz), 1107
Island (Johnston) Nuclear Explosion Disturbance in the Ionospheric *F*-Region following the (C H Cummack and G A M King), B A 32
Island (Macquarie) Transport of Driftwood from South America to Tasmania and (Prof H N Barber, Dr H E Dadswell and H D Ingle), 203

Island (Seymour), Antarctica Fossil Pollen from (Lucy M Cranwell), 1782
Islands (Ongul), in the Antarctic Natural Remanent Magnetization of Pre-Cambrian Gneiss of (T Nagata and Y Shimizu), 1472
Islets of Langerhans Actual Distribution of the Number and Volume of the, in Different Size Classes in Non-diabetic Humans of Varying Ages (Bo Hellman), 1498
Isoalleles (Different Wild-Type) Effect of, on Crossing-over in *Drosophila melanogaster* (M M Green), 294
Iso-Antigens of Rabbit γ-Globulin (S Dubiski, Danuta Skalba, Anna Dubiska and Dr A Kelus), 1811
Isolated *d*-Amino-Acid Oxidase Systems Effect of Chlorpromazine upon (Dr Andrew Lasslo and Anne L Meyer), 1922
Isolated Blastomeres of Mouse Eggs Experiments on the Development of (Dr Andrzej K Tarkowski), 1286
Isolated Chloroplasts Destruction of Carotenoids in (J Friend and T O M Nakayama), B A 66
Isolated, Fresh Nerve Cells and Glial Cells from Control and Stimulated Animals Quantitative Assay of Compounds in (Prof Holger Hydén), 433
Isolated Mitochondria Effect of Reduced Diphosphopyridine Nucleotide on the Swelling of (Dr G Di Sabato), *erratum*, 95
Isolated Nuclei Transplantation Immunity—Separation of Antigenic Components from (André Castermans and André Oth), 1224
Isolated Plain Muscles Promoting Effect of Urea on the *in vitro* Passive Sensitization of, with Precipitating Antibody (R Binaghi, Dr B N Halpern, P Liacopoulos and T Neveu), 1805
Isolated Rat Liver Mitochondria Protein Synthesis and Oxidative Phosphorylation in (P J Reis, J L Coote and T S Work), 165
Isolated Rat Uterus Some Pharmacological Effects of Staphylolysin on the (Dr R Wiegershausen), 2017
Isolated Rat Ventricle Preparation Potentiation of Contractions after Rest in the (Dr R L Speirs), 66
Isolated Thymus Nuclei Monovalent Cations and the Incorporation of Metabolites by (Dr Theodore R Breitman and Dr George C Webster), 637
Isolated and Perfused Rat Spleen Production of γ- and α-Globulins by the (Dr E Espinosa), 1801
Isolating and Cloning Cells of Higher Plants A New Technique for (Ludwig Bergmann), 648
Isolation of 2-Aminoethane Phosphonic Acid from Rumen Protozoa (Masaaki Horiguchi and Makoto Kandatsu), 901
Isolation of the Antifungal Substance, 6-Methoxybenzoxazolinone, from Field Corn (*Zea mays* L) in Canada (N J Whitney and C G Mortimore), 1320
Isolation of Basidiomycetes from the Soil (J H Warcup), 506
Isolation of Echinochrome A from the Spines of the Sea Urchin, *Diadema setosum* (Leske), (Kokichi Nishibori), 1234
Isolation of Fatty Alcohols with Plant-Growth Promoting Activity from Maryland Mammoth Tobacco (Dr A J Vlitos and Dr D G Crosby), 462
Isolation of 24-Methylene-cholesterol from Honey Bees (*Apis mellifica* L), (Dr M Barbier, Prof T Reichstein, Dr O Schindler and Prof E Lederer), 732
Isolation of Tobacco Leaf Cells capable of Supporting Virus Multiplication (Prof Milton Zaitlin), 1002
Isolation of Thrombins Rivanol, Resin and the (Dr Kent D Miller), 450
Isolation and Purification of Nitrate Reductase from Embryos of Germinating Wheat (D Spencer), 682
Isomeric O-Methyl Ethers of Ethyl di-(4-hydroxycoumarinyl-3)-Acetate (the Anti-coagulant Drug Pelentane or Thromexane), (Dr Eduard Knobloch), 1568
Isomerism (*Cis-trans*), and Steric Hindrance (Photochemical and Stereochemical Properties of Carotenoids at Low Temperatures), (John N Loeb, Paul K Brown and Prof George Wald), 617
Isomerization to the Tropylium Ion induced by Electron Impact and its Significance (Dr W Hanuš), 1796
Isomers of Vitamin A in Fish Liver Oils (Patricia S Brown, William P Blum and Max H Stern), 1377
Isomers (*Meta*- and *Para*-), of the Xylenes, Cresols and Toluidines by Gas Solid Chromatography Separation of the (M A Hughes, D White and Prof A L Roberts), 1796
Isostatic Compensation and Mohorovičić Discontinuity, etc Depth of, in Continental and Oceanic Areas (J N Nanda), 629
Isotherm (Langmuir Adsorption) Kinetic Study of Dextransucrase based on the (W Brock Neely and C F Thompson), B A 64
Isotope Variations (Oxygen), in Antarctic Snow Samples (Dr R Gonfiantini and Prof E Picciotto), 1557
Isotopes Organic Syntheses with (Arthur Murray, III, and D Lloyd Williams), Part 2, Organic Compounds labelled with Isotopes of the Halogens, Hydrogen, Nitrogen, Oxygen, Phosphorus and Sulfur, *review* by Dr G Eglinton, 1830
Isotopes in Organic Syntheses, *review* by Dr G Eglinton, 1830
Isotopes (Oxygen) Ratio in Fossil Calcareous Organisms Determination of the Temperatures of Ancient Seas by the Measurement of the (Y A Birstein), 1025
Isotopic Composition of Boron (D C Newton, A C Tyrrell and J Sanders), 185
Isotopically Exchangeable Phosphate in Soil Effect of the Level of Microbial Population on (Dr P Newbould and Dr R L Lucas), 1155
Itano, Dr Harvey A , and Robinson, Elizabeth Properties and Inheritance of Haemoglobin by Asymmetric Recombination, 1468
Ito, Prof T Twinning of Crystals (Twinning as a Building Principle of Crystals), 1911
Itschner, D Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Ives, W Appointed executive officer of the Australian Commonwealth Scientific and Industrial Research Organization, 1985 , work of, 1985
Iwadare, Dr J Nuclear Forces and the Few-Nucleon Problem (The Meson-Theoretical Two-Nucleon Interaction and its Comparison with Experimental Data), 1113 , (Photonuclear Reactions with Light Nuclei), 1114
Iwanow, Prof A W Elected a member of the Zoology Section of the Leopoldina Academy of Natural Sciences, 595
Iwinski, T Theory of Beams (translated from the Polish by E P Bernat), *review* by T M Charlton, 1976

JACCARD, C (Granicher, H , and) Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 157
Jackman, Dr L M , and others Biological Origin and Configuration of 10-Hydroxy-Δ^{2}-decenoic Acid, 634
Jackson, Anne-Louise (Rajam, Dr P C , and) *In vitro* Labelling of Antibody Globulin by Tritium Exchange, 375
Jackson, E F Appointed director of the Institute of Statistics in the University of Oxford, 943
Jackson, Dr G A D , and Barakat, S E Y The Organic Acids in Rose Hips, 1953
Jackson, Dr G A D , and Wood, R B Presence in Rose Hips of Substances inhibiting the Oxidation of Ascorbic Acid, 902
Jackson, Dr G A D (Prosser, M V , and) Induction of Parthenocarpy in *Rosa arvensis* Huds with Gibberellic Acid, 108
Jackson, Prof J D The Physics of Elementary Particles, *review* by P T Matthews, 1677
Jackson, Dr J S , and Palmer, P F Special Ceramics (Apparatus designed for Hot-pressing small specimens of Refractory Hard Materials to High Density), 1116
Jackson, Prof L C Measurement of the Thickness of the Helium Film (Duddell Medal Address to the Physical Society), 954
Jackson, Prof M L Soil Chemical Analysis, *review* by J M Bremner, 1093
Jackson, V R Personnel Management and Technological Change (Government Policy and Company Pension Schemes for Manual Workers), 1614
Jackson, Sir Willis Elected president of the Institution of Electrical Engineers, B A 16
Jacob, F , and Wollman, E Cytoplasmic Inheritance (Lysogeny and Zygotic Induction), 1012
Jacob, Dr L (Chisholm, Margaret, and) Current Fluctuations in the Oxide Cathode, 1058
Jacobs, Dr Morris B The Chemical Analysis of Foods and Food Products, third edition, *review* by Dr V H Booth, 1347
Jacobs, P W M (Hill, R J , and) Field Effects on Chemisorbed Films in Electron Emission Microscopy, 895
Jacobsen, Dr E H Ultrasonic Vibrations at 10,000 Megacycles, *erratum*, 27
Jacobson, Howard Boone, and Roucek, Joseph S (edited by) Automation and Society, *review* by R Brightman, 1438
Jacobson, M , and others Chemical Nature of a Plant-Virus Inhibitor from Rice, 1146
Jacobson, Robert A , and others Structure of Cellobiose, 1719
Jaffe, W P , and others Unidentified Growth Factors, 271
Jaffe, W P (Wakelam, J A , and) Unidentified Chick Growth Factors, 272
Jakubovic, Dr A O Anion Exchangers based on Cellulose, 1065
Jameel, M Awarded an Overseas Scholarship by the Royal Commission for the Exhibition of 1851, 409
James of Rusholme, Lord T H Huxley, *review*, B A 2
James, Dr A T Awarded a John Price Wetherill Medal of the Franklin Institute, 857
James, Prof E O Myth and Ritual in the Ancient Near East, *review* by Prof Norman W Porteous, 1972
James, Philip The Country House and the Museum, 598
James, Suzanne M , and Fiset, Paul Serum Inhibitors of Asian Strains of Influenza Virus, 1656
Janak, Dr J Gas Chromatography (Application of Gas Chromatography to the Identification of Structure of Involatile Substances by Pyrolysis, 1199
Jancso, Prof N , and others A Method for *in vitro* Investigation of the Colloid-storing Function of Histiocytes, 1070
Jancso-Gabor, Aurelia, and others A Method for *in vitro* Investigation of the Colloid-storing Function of Histiocytes, 1070
Janeček, J , and others Influence of DL-beta-Phenylserine on the Synthesis of Proteins in *Escherchia coli*, 1895
Janes, B S *Sporidesmium bakeri* recorded from Victoria, Australia, 1327
Jansen, Dr E G Opening Address at the Cape Town Science Exhibition (1959), 952
Jansonius, J N (Drenth, J , and) The Unit Cell of Mercuripapian Crystals, 1718
Janus, J W Gelation (The Formation and Structure of Gelatin Gels), 863
Japan Concentration of Caesium-137 in the Coastal Waters of, (1959), (Noboru Yamagata), 1813
  Mineralogical Study on Clays of (Dr Toshio Sudo), *review* by Dr D M C MacEwan, 1439
Japanese Geochemical Society Position and Activities of the (Prof K Sugawara), 1193
Japanese Nuclear Power Station, 407
Jarai, I , and others Thermoregulatory Heat Production in the Brain, 993
Jardine, W Graham Appointed lecturer in geology at the University of Glasgow, 1915
Jarman, Dr M Electrical Activity in the Muscle Cells of *Ascaris lumbricoides*, 1244
Jaw (Piltdown Skull and) Radiocarbon Dating of the (Prof H de Vries and Dr K P Oakley), 224
Jay, G T F , and others Identification of the High-Temperature Constituent in Mild Steel Surface-Hardened by Carbo-Nitriding, 1312
Jayawant, Dr B V Appointed lecturer in electrical engineering at Queen's University, Belfast, 322
Jeffares, Prof A Norman, and Davies, M Bryn The Scientific Background, *review* by Dr W L Sumner, 5
Jeffery, Dr P M (Compston, W , and) Anomalous 'Common Strontium' in Graphite, 1792
Jeffreys, Sir Harold The Earth—its Origin, History and Physical Constitution, fourth edition, *review* by Prof B Gutenberg, 1007
Jeljaszewicz, Dr J (Wlodarczek, Dr K , and) Influence of Coagulase on the Growth of Staphylococci in Normal Human Serum, 1514
Jelley, Dr J V Cerenkov Radiation and its Applications, *review*, 1260
Jellyfish A Viviparous Deep-Sea (Dr F S Russell), 1527
Jenkin, Dr C R , and Rowley, Prof D Opsonins as Determinants of Survival in Intraperitoneal Infections of Mice, 474
Jenkins, Dr G M New Techniques in the Analysis of Noise and Vibration (Statistical Implications of obtaining a Spectrum via an Autocorrelogram), 415
Jenkins, W Lloyd Appointed lecturer in the Department of Chemistry in the University College of Rhodesia and Nyasaland, with responsibility for teaching agricultural chemistry, 508

Jennings, W H (Hagins, Dr W A, and) Energy Transfer with special reference to Biological Systems (Localization as Opposed to Migration of the Excitation in the Retinal Rods), 690
Jennison, Dr R C (Davies, Dr R D, and) Red-Shift Absorption Spectrum of the Cygnus-A Radio Source, 803
Jensen, H L, and others A New Nitrogen-fixing Bacterium, 1743
Jensen, P K Corticosterone Inhibition of Pyridine Nucleotide Oxidase from Heart Sarcosomes, 451
Jensen, Rue, and Hill, H J (edited by F X Gassner, in association with) Proceedings of the Third Symposium on Reproduction and Infertility, Colorado State University, *review* by Dr T Mann, 1434
Jenson, Dr V G Appointed lecturer in chemical engineering at the University of Birmingham, 684, 1362
Jephcott, D F Ionization Phenomena in Gases (Measurements of the Velocity and Damping of Alfvén Waves), 1356
Jerrard, H G, and Simmons, B A W Dielectric Studies on Deoxyribonucleic Acid, 1715
Jet (Gas) Blunt-Nosed Bodies in a High-Temperature (F R Sedlund and Prof C C Chang), 812
Jet Aircraft Noise Effect of, on Hearing (Surg Lieut R R A Coles and J J Knight), 1803
Jet Propulsion, *review* by D G King-Hele, 1346
Jets and Rockets (A Barker, T R F Nonweiler and R Smelt), *review* by D G King-Hele, 1346
Jewell, P A, and Hawkins, A E At the Conference of the Mammal Society of the British Isles (Normal Diet of the Water Shrew), 29
Jewkes, Prof J How Much Science? (Presidential Address to Section F (Economics) of the British Association for the Advancement of Science), B A 44
Jha, Asharfi, and Posnette, Dr A F Transmission of a Virus to Strawberry Plants by a Nemotode (*Xiphinema* sp), 962, *erratum*, 1192
Jimbo, T Origin and Dispersal of Flowering Plants (Angiosperms in various Tertiary Floras of Japan), 1201
Jirka, J, and others Haemodynamics in Essential Hypertension, 1643
Job Fitting the, to the Worker—a Survey of American and European Working Conditions in Industry (European Productivity Agency of the Organization for European Economic Co-operation, Project 335), 422
Jobst, C, and others Effect of Sexual Maturation and Castration on the Sex Chromatin Pattern in the Male Rat, 1239
Johnin Protein Preparation of a Highly Purified Carbohydrate-free (E Annau), 1642
Johns Hopkins University Studies in Historical and Political Science, Series 76, No 1, Trends in Birth Rates in the United States since 1870 (Dr Bernard Okun), *review*, 134
Johnson, A A, and others Dislocation Arrangements in Molybdenum, 356
Johnson, Dr Bruce Ants and Form Reversal in Aphids, 740
Johnson, C G, and others New Pests of Cocoa (*Theobroma cacao* L) in Ghana following Applications of Insecticides, 2040
Johnson, Dr C H Promoted to Chief Scientific Officer and appointed director of the Explosives Research and Development Establishment of the Ministry of Aviation, Waltham Abbey, 1448, 1775, work of, 1775
Johnson, D H, and Morth, Dr H T Value of Contour Analysis in Equatorial Meteorology, 1372
Johnson, Eleanor, and others Equilibrium Constant of the Galactokinase Reaction and Free Energy of Hydrolysis of Adenosine Triphosphate, 1925
Johnson, Dr Francis S Telluric Origin of the Whistler Medium, 1787
Johnson, G A, and Neale, Dr S A Dielectric Absorption in Dispersed Systems, 898
Johnson, Dr Julian F (Porter, Dr Roger S, and) Volatile Liquid Partition Chromatography, 978
Johnson, Prof L P V Awarded a Research Fellowship in genetics in the University of Birmingham, 1688
Johnson, Dr T H, and others Carbonic Anhydrase in the Deciduoma of the Rat, 961
Johnson, Matthey and Co, Ltd Production of all the Rare Earth Metals, 683
Johnston, F B, and others Fine Structure in Cells of Pea and Wheat Embryos, 505
Johnston, Norah C, and others Extraction and Purification of 'Queen Substance' from Queen Bees, 1871
Johnston Island Nuclear Explosion Disturbance in the Ionospheric F-Region following the (C H Cummack and G A M King), B A 32
Johnstone, Dr R A W (Carruthers, Dr W, and) Composition of a Paraffin Wax Fraction from Tobacco Leaf and Tobacco Smoke, 1131
'Joining of Metals' Conference at the University of Birmingham Third (The Electric Arc in Welding), 1030
Joint Action of Gibberellic Acid and Coumarin in Germination (A M Mayer), 826
Joint Advisory Council, National Report of an inquiry into the Efficient Use of Man-power in Industry (Ministry of Labour and National Service), 25
Joint British Committee for Vacuum Science and Technology Formation of a, 1191
Joints (Animal) Mechanism of—Sponge-hydrostatic and Weeping Bearings (Dr C W McCutchen), 1284, Experimental Evidence for Weeping Lubrication in Mammalian Joints (P R Lewis and Dr C W McCutchen), 1285
Joints (Mammalian) Experimental Evidence for Weeping Lubrication in (Mechanism of Animal Joints), (P R Lewis and Dr C W McCutchen), 1285
Joly, Dr Louis-P, and Nadeau, Dr Guy Evidence of Side-Chain Cleavage during the Reaction of Epinephrine and Norepinephrine with Ethylene Diamine, 1483
Jones, A G Analytical Chemistry, *review* by Dr A M G Macdonald, 1677
Jones (Bence) Proteinuria associated with a Transplantable Mouse Plasma-Cell Neoplasm (John L Fahey and Michael Potter), 654, *erratum*, 1108
Jones, Dr B M Inhibition of Rous I Sarcoma Metastases by a Copper-Catalyst Blocking Agent, 1963
Jones, D C Rhys, and others Compaction of Briquettes, 120
Jones, D W Biological Fibres, B A 25
Jones, D W Appointed Research Fellow in physical metallurgy in the University of Birmingham, 684
Jones, E (Jones, Prof F Llewellyn, and) Ionization Phenomena in Gases (Temporal Growth of Ionization), 1354
Jones, E, and others Ionization Phenomena in Gases, 1353
Jones, Ernest Turner Elected deputy chairman of the NATO Advisory Group for Aeronautical Research and Development, 1108
Jones, Prof E W The Native Pinewoods of Scotland, *review*, 133
Jones, Prof F Llewellyn Appointed acting principal of the University College of Swansea, 410
Jones, Prof F Llewellyn (Davies, D K, and) Ionization Phenomena in Gases (Influence of Collisions of the Second Kind between Excited and Neutral Molecules, on Secondary Ionization in Hydrogen), 1354
Jones, Prof F Llewellyn, and others Ionization Phenomena in Gases (Recent Measurements on the Growth of Pre-breakdown Ionization Currents for Air), 1354
Jones, Prof F Llewellyn, and Jones, E Ionization Phenomena in Gases (Temporal Growth of Ionization), 1354
Jones, F O Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Molybdenum–Rhenium (50/50) and Uranium–Zirconium (70/30) Alloys), 691, (Titanium Carbide (TiC) and Tungsten Carbide (WC) decompose at Temperatures lower than their Melting Points), 691
Jones, June I Ergonomics, its Place in Industry, B A 20
Jones, Dr J P Title of senior lecturer in aeronautical engineering at the University of Southampton conferred on, 595
Jones, Dr J W The Salmon, *review* by Dr Arthur E J Went, 577
Eel Migration, 1281
Jones, Dr L H P, and others Cause of Wear in Sheeps' Teeth, 1583
Jones, Prof Ll Wynn Measurement of Values, *review*, 1010
Jones, Dr N S Appointed to a senior lectureship in marine biology in the University of Liverpool, 410
Jones, P M, and others Optical Activity of Stercobilin and *d*-Urobilin, 41
Jones, Dr R Clark, and others Fluctuations in Photon Streams, 967
Jones, R E Ionization Phenomena in Gases (Sparks in Long Gaps), 1355
Jones, R H Appointed assistant lecturer in civil engineering at the University of Birmingham, 1915
Jones, Prof R V Substance and Shadow, *review*, 1752
Jones, T A, and others Soil and Land-Use Surveys of the Regional Research Centre of the British Caribbean, No 3, St Vincent, 27
Jones, W A, and others Chemical Nature of a Plant-Virus Inhibitor from Rice, 1146
Jones, Dr W D *Obituary* of H W Greenwood, 404
Jones, Prof William O Elected a member of the Botany Section of the Leopoldina Academy of Natural Sciences, 595
Jones, Dr W P Flow of Compressible Fluids, *review*, 485
Jongen, P, et autres Carte des Sols et de la Vegetation du Congo Belge et du Ruanda-Urundi, 6, Yangambi, Planchette 3, Lilanda, A, Sols, B, Vegetation (Institut National pour l'Etude Agronomique du Congo Belge), 27
Jongerius, H M, and others Ionization Phenomena in Gases (Optical Excitation Functions in experiments with Mercury and Helium), 1354
Jonxis, J H P, and Delafresnaye, J F (edited by) Abnormal Haemoglobins—a Symposium organized by the Council for International Organizations of Medical Sciences, *review* by Dr J A M Ager, 840
Jordan, Prof D C, and Inniss, W E Selective Inhibition of Ribonucleic Acid Synthesis in *Staphylococcus aureus* by Vancomycin, 1894
Jordan, Dr F T W Appointed to a senior lectureship in veterinary preventive medicine in the University of Liverpool, 410
Jordan, Dr L A Retirement as founder-director of the Research Association of British Paint, Colour and Varnish Manufacturers, 852, work of, 852
Joseph, Dr J Polar Front Survey (Hydrography—North Atlantic Ocean), 1182
Joslin, Major-General S W Appointed chief inspector of nuclear installations, 680
Joubert, Dr J M, and others Evidence for a Hydrate of Cellulose from Studies of its Surface Properties, 1561
Journal of Applied Polymer Science, Vol 1, No 1, 784
Journal of Nutrition Appointment of Dr Richard H Barnes as editor, 156
Appointment of Dr Cyril L Comar as associate editor, 156
Journal of Research of the United States National Bureau of Standards to be published in four separate Sections, 320
Journal (New), of Glass Technology, 855
Journal (New), of Psychopharmacology, 940
Journals (Scientific) Effects of Printing Types and Formats on the Comprehension of (E C Poulton), 1824
Jowett, D Adaptation of a Lead-tolerant Population of *Agrostis tenuis* to Low Soil Fertility, 43
Jowsey, J R, and others Effect of Thioctic Acid on Gain in Body-Weight by Turkey Poults, 1323
Jubb, R A Eels in Southern Africa, 827
Jukes, J D Thermonuclear Processes (Extracting Electrical Energy directly from any Fusion Reactor which uses the Principle of Magnetic Confinement), 241
Julian, F A (Allen, K W, and), and others The Tandem Generators of the United Kingdom Atomic Energy Authority, 303
Junction Transistor Electronics (Richard B Burley), *review* by J W R Griffiths, 838
Jung, Prof Jean Précis de Pétrographie, *review* by J C M Taylor, 1677
Jupiter Anomalous Continuum Radiation from (Dr Eugene E Epstein), 52
Jurassic Period Possible Reversals of the Earth's Magnetic Field in the (Dr R W Girdler), 540
Jurkowitz, Dr Lawrence Photochemical and Stereochemical Properties of Carotenoids at Low Temperatures—Photochemical Behaviour of Retinene, 614
Juska, F V (Hanson, A A, and) A 'Progressive' Mutation induced in *Poa pratensis* L by Ionizing Radiation, 1000
Juul, Helge Conference of the Co-ordinating Advisory Committee on Oil Pollution of the Sea opened by, 950
Juvenile Delinquency Preventing, 1203
Juvenile Hormone Extracts of Insects Prothoracic Gland Stimulation by (Dr Lawrence I Gilbert and Dr Howard A Schneiderman), 171
Juvenility in *Marsilea* and certain other Plants Effects of Gibberellic Acid on (Dr A Allsopp), 1575

KAFIG, Emanuel (Meryman, Dr Harold T , and) Survival of Spermatozoa following Drying, 470
Kahlson, Prof G , and Rosengren, Elsa Prevention of Foetal Development by Enzyme Inhibition, 1238
Kahn, R P , and others Chemical Nature of a Plant-Virus Inhibitor from Rice, 1146
Kail, J A E , and Powles, Dr J G Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Kallman, Prof H P Energy Transfer with special reference to Biological Systems (Electronic Energy Transfer in Solution), 689
Kalmus, Dr H Orientation of Animals to Polarized Light, 228
Kamahora, Juntarô, and others Transformations of Myxoma into Vaccinia or Ectromelia Virus in Tissue Culture, 1152
Kamiya, Takaaki, and others Microbiological Transformation of a Cardiac Aglycone, 469
Kampa, Dr Elizabeth M (Boden, Dr Brian P , and) Spectral Composition of the Luminescence of the Euphausiid *Thysanoessa raschii*, 1321
Kanazawa, Dr K , and Imai, A Pure Culture of the Pathogenic Agent of Tyzzer's Disease of Mice, 1810
Kanda, Z , and others Chemistry and Pharmacology of 16-Acetyl Digitalinum Verum, 1414
Kandatsu, Makoto (Horiguchi, Masaaki, and) Isolation of 2-Aminoethane Phosphonic Acid from Rumen Protozoa, 901
Kantrowitz, A , and others Ionization Phenomena in Gases (Use of Collision-free Shocks to Study Dissipation Mechanisms in Collision-free Plasmas), 1357
Kapany, Dr N S High-Resolution Fibre Optics using Sub-Micron Multiple Fibres, 881
Kaplan, Colin Reactivation of Vaccinia Virus Inactivated by Mercury, 1074
Kaplan, Dr Martin M , and others Statement on Biological and Chemical Warfare, 1018
Kaplan, Dr Wilfred Ordinary Differential Equations, *review* by Prof T A A Broadbent, 6
Kaplansky, Irving, and others Some Aspects of Analysis and Probability, *review* by D G Kendall, 214
Kapoor, Dr A L Appointed an I C I Fellow in chemistry at University College, Dublin, 410
Kargin, W A Macromolecules (Physics of Polymers), 1689
Karnofsky, Dr David A , and others Reversal of Effects of 2-Substituted Thiadiazoles by Nicotinamide Analogues and Precurors, 1805
Karp, Arthur Colour-Image Synthesis with Two Unorthodox Primaries, 710
Kashiwagi, Dr Tsutomu Mechanism of the Antidiuretic Effect of Vasopressin, 991
Kashkai, Prof M A Alpine Mineral Fissures (Mineral Deposits in the Caucasus Mountains akin to those of the Alpine Fissures), 1910
Kasten, Prof Frederick H , and others Fluorescent Schiff-Type Reagents for Cytochemical Detection of Polyaldehyde Moieties in Sections and Smears, 1797
Kasting, R , and others Biosynthesis of some Amino-Acids from Sucrose by Germinating Uredospores of Wheat Stem Rust, Race 15B, 1943
Katayama, K , and others Chemistry and Pharmacology of 16-Acetyl Digitalinum Verum, 1414
Katchalsky, Prof A Flow Properties of Biological Systems (Experiments on Osmotic Effects in Individual Erythrocytes), 1540
Katchalsky, Prof A (Paecht, Dr Mella, and) Spontaneous De-amination of Amino-acid Phosphates under Physiological Conditions, 1489
Kato, J Plant Growth Regulation (Recent Work with the Gibberellins), 600
Kato, J , and others Plant Growth Activities of 5- and 8-Halogeno-Dihydro- and Tetrahydro-1-naphthoic Acids, 1415
Kato, Shunji, and Koizumi, Masao Reductive Photo-bleaching of Eosine—Primary Processes indicated by the Flash Technique, 1620
Kato, Shunji, and others Reductive Photo-bleaching of Eosine—Effect of Added Substances on the Rate of Reductive Photo-bleaching, 1620
Kats, A (van Wieringen, J S , and) Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Katsoyannis, Panayotis G , and du Vigneaud, Prof Vincent Active Principles of the Neurohypophysis of Cold-blooded Vertebrates—Arginine Vasotocin, 1465
Katz, Prof B (edited by Prof J A V Butler and) Progress in Biophysics and Biophysical Chemistry, Vol 9, *review* by P A Merton, 1092
Katz, Prof B , and others Dissociation of the 'Surface Membrane Complex' in Atrophic Muscle Fibres, 1507
Katz, Prof Edward Inhibition of Actinomycin Synthesis by D-Valine, 1666
Katz, Joseph J , and others Culture of Algae and other Micro-organisms in Deuterium Oxide, 729
  Chloroplast Pigments of Deuterated Green Algae, 730
Kaubler, Prof Rudolf Elected a member of the Geography Section of the Leopoldina Academy of Natural Sciences, 595
Kauchuk i Rezina An English translation under the title *Soviet Rubber Technology* to be published by the Research Association of British Rubber Manufacturers, 505
Kaudewitz, Dr F At the 139th Annual Meeting of the Swiss Society for Natural Sciences (Methoden, Denkweise und Ergebnisse der Erbforschung an Bakterien), 1454
Kaufman, H R (Zlatkis, Prof Albert, and) Use of Coated Tubing as Columns for Gas Chromatography, 2010
Kavanagh, James Awarded a junior post-graduate agricultural research scholarship by An Foras Talúntais (the Agricultural Institute of Ireland), 1612
Kawin, Dr Bergene Distribution of Promethium Plasma Fractions in Rats, 1722
  Hormone Effects on Early Distribution and Disappearance from the Blood of Promethium-147 in Rats, 1816
Kay, Dr H Appointed to the chair of psychology in the University of Sheffield, 93 , work of, 93
Kaye, W G , and others Coal Science (Carbonization—Effect of Macerals on Volume Changes in Briquettes during Carbonization), 413
Kean, R I Bionomics of the Brush-tailed Opossum *Trichosurus vulpecula* in New Zealand, 1388
Keay, J N , and others Preparation of Crystalline *trans-trans* Methyl Linoleate Hydroperoxide, 816
Keay, R W J Explanatory Notes to accompany a Vegetation Map of Africa (with a French translation by A Aubréville), 594
Keck, Dr David D Resignation as acting director of the New York Botanical Garden in order to remain permanently as programme director for systematic biology at the Division of Biological and Medical Sciences of the United States National Science Foundation, 680
Kedrov, B M (edited by) Periodic Law (D I Mendeleieff), Russian Text, *review* by Prof S I Tomkeieff, 1598
Keehn, Prof J D , and Nakkash, Sanniyah Effect of a Signal Contingent upon an Avoidance Response, 566
Keen, Dr A W Modern Network Theory in Electrical Engineering (Place and Teaching of Electrical Network Theory in Universities and Technical Colleges) 1692
Keeping Up to Date with Chromatography, *review* by Dr R Consden, 1436
Keil, Dr A (Schmidt, Prof W J , and) Die gesunden und die erkrankten Zahngewebe des Menschen und der Wirbeltiere im Polarisationsmikroscop, *review* by Prof A I Darling, 218
Keilin, David Elected an Honorary Member of the American Academy of Arts and Sciences, 410
Kekwick, R G O , and others Incorporation of DL-[2-^{14}C] Mevalonic Acid Lactone into Polyisoprene, 268, *erratum*, 772
Kelemen, Dr E Awarded a scholarship by the Lady Tata Memorial Trust, for research on Leukaemia and allied Diseases, 507
Kelemen, M V , and others Teichoic Acids from Bacterial Walls—Composition of Teichoic Acids from a Number of Bacterial Walls, 247
Keller, Dr A Macromolecules (Physics of Polymers), 1689
Keller, Dr A , and others Evidence for Distinct Sectors in Polymer Single Crystals, 810
Kellermeyer, Robert W , and others Glucose-6-phosphate Dehydrogenase and Human Erythrocytes—Mechanism of Inactivation of Glucose-6-phosphate Dehydrogenase in Human Erythrocytes, 1292
Kelley, M T (edited by) Analytical Chemistry, Vol I, *review* by G W C Milner, 1524
Kellner, G , and others Production of Serum Albumin and of Globulins by Chick Mesenchymal Tissue and by HeLa Tumour Tissue in Culture, 361, *erratum*, 943
Kellogg, Prof Paul J (Ney, Prof Edward P , and) Kellogg and Ney's Model of the Solar Corona, 1122
Kellogg and Ney's Model of the Solar Corona (Dr D E Blackwell and Dr D W Dewhirst), 1120 , (Prof Edward P Ney and Prof Paul J Kellogg), 1122
Kelly, B K A Least-Squares Solution for a Linear Relation between Two Observed Quantities, 1086
Kelly, J C Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Sessile Drop Surface Tension Measurement of Tantalum), 692 , (Evaporation of Thin Films of Tantalum and Zirconium), 692
Kelson, Dr Keith R (Hall, Prof E Raymond, and) The Mammals of North America, *review* by Peter Crowcroft, 1524
Kelus, Dr A , and others *Iso*-Antigens of Rabbit γ-Globulin, 1811
Kemula, Prof Wiktor, and others Influence of Gold in a Mercury Electrode on certain Electrode Processes, B A 56
  Influence of Platinum in Mercury on the Mechanism of Electrode Reactions at the Mercury Electrode, 1795
Kendall, D G Surveys in 'Applied' Mathematics, *review*, 214
  Stochastic Rectification of Non-linear Clocks, 1476
Kendall, R , and others Awarded the Brabazon Premium of the British Institution of Radio Engineers, 857
Kendrew, Dr J C At the first Conference of the British Computer Society (Recent work on the Structure of Myoglobin), 945
Kendrick, S B Promoted to Senior Principal Scientific Officer in the Scientific Civil Service 858 , work of, 858
Kenkare, U W (Braganca, Dr Beatriz M , and) Flavins as Components of Folic Acid Reductases, 1488
Kennedy, Dr G C , and Crawford, Dr J D An Antimineralocorticoid Action of some Saluretic Sulphonamides, 1492
Kennedy, Jr (Joseph P) Memorial Foundation Gift of 1,000,000 dollars to the Massachusetts General Hospital, for the establishment of the Joseph P Kennedy, Jr Laboratories for research on Mental Retardation 594
Kennett, B H (Huelin, Dr F E , and) Nature of the Olefines produced by Apples, 996 , *errata*, 1535
Kenrick, K L Records and Activities of the Birmingham Natural History and Philosophical Society, 1024
Kent, Dr Andrew Chemistry in the Eighteenth Century, 1452
Kent, Dr A K Significance of the Time Relations of Humorally Co-ordinated Chromatic Responses, 2027
Kenya (North) Banks (Dr J F C Morgans), 259
Keratin Permanent Set, Supercontraction and Urea-Bisulphite Solubility—the Proton-Transfer Nature of some Changes in, and the Analogy with Muscle Contraction (Dr P T Speakman), 339
Kerkut, Dr G A , and others Electron Spin Resonance Investigations of *Allium cepa* and *Calliphora vomitoria*, 1402
Kerr, Prof Donald, and others Statement on Biological and Chemical Warfare, 1018
Kerr, Sir Hamilton Museums and Finance, 598
Kerr, Dr T Histology, *review*, 752
Kerridge, J F , and others Dislocation Arrangements in Molybdenum, 356
Kershaw, Prof William Evolution of Host–Parasite Relationships, 760
Kersten, Helga, and Zurn, L Hydroxylysine in Wool, 1490
Kessler, Alexander, and others Chromatographic Fractionation of Rat Tail Tendon Collagen, 1640
Kessler, M F , and Večeřikova, V Coal Science (Physical and Physicochemical Measurements on Cokes), 414
Keto-Acid Hydrazones Thermal Decarboxylation of some (Ambrose M Tokushige and Prof Elton S Cook), 267
Keto-Acids (Blood), in Kwashiorkor (Prof J C Edozien), 1150
α-Ketoglutaric Acid and Pyruvic Acid in Blood, Cerebrospinal Fluid and Urine (Dr E Zelnicek), 727
Ketosis of Pregnancy Blood Cortisol in the Sheep—Normal Concentration and Changes in (H R Lindner), 1645
Kew, Past and Present, *review* by Dr Richard A Howard, 1345
Kewensis, Index Supplementum Duodecimum, 1951-1955 (edited by Dr George Taylor), *review* by Prof T G Tutin, 129

Khami Ruins—Report on Excavations undertaken for the Commission for the Preservation of Natural and Historical Monuments and Relics, Southern Rhodesia, 1947-1955 (K R Robinson), *review* by R R Inskeep, 1349
Khan, N A (Mukherjee, D , and) A New Enzyme System in the Tamarind, 1140
Khapra Beetle Dormancy of the—Quiescence or Diapause (H D Burges), 1741
Khazchenko, — Ionization Phenomena in Gases (The Interaction of a Beam of Charged Particles with a Plasma), 1356
Khorana, Dr H Gobind The Structure of Science, B A 8
Kidney and Adjacent Tissues (Liver,) Tumourigenesis in Ovaries of Mice transplanted to the (Dr Mary J Guthrie), 916
Kidney and Liver Function in the Sheep Effects of Carbon Tetrachloride on (Dr B P Setchell), 1242
Kidney (Pig) Tissue Culture Monolayers Effect of Proflavine on the Formation of the Virus of Foot-and-Mouth Disease and its Infective Ribonucleic Acid in (F Brown and Doreen L Stewart), B A 74
Kidney (Rat) Deaminases of Adenylic Acid and Adenosine in (Dr M Zydowo), 1641
Kidney Cell Cultures (Monkey), infected with Poliomyelitis Virus and Incubated at 22°-30°C Appearance of Crystalline Needles in (Dr Esther Tenenbaum), 1657
Kidney Cells (Calf) Interferon produced by Cultures of (Dr D A J Tyrrell), 452
Kidney Cells (Liver and) Absorbancy Measurements on (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Dr Bo Thorell and Prof Britton Chance), 934
Kidson, C Coast Erosion and Accretion, 500
Kienhuis, H , and others Action of Anhydrous Formic Acid on Peptides and Proteins 2015
Kihara, Hitoshi Elected an Honorary Member of the American Academy of Arts and Sciences, 410
Kilburn, Dr T At the first Conference of the British Computer Society (Very Fast Computers—The *Muse* Project), 945
Killifish Hybrids Effect of Thiouracil and Thyroxine on Development and Growth of Cutaneous Melanoma in (Prof A Stolk), 562
Kilmister, Dr C W Title of reader in applied mathematics in the University of London (at King's College) conferred on, 1273
Kimura, Dr Tokuji, and Singer, Dr Thomas P Functional Organization of the Respiratory Chain in Liver Mitochondria, 791
Kinard, Dr F W , and others Relation of Ethanol Metabolism to Several Factors in the Rat, 1721
Kinetic Chain Lifetimes A Modified Rotating-Sector Method of measuring (Dr W I Bengough, S A McIntosh and R A M Thomson), 266
Kinetic Heating Structural Effects of (Royal Aeronautical Society Discussion on), 30
Kinetic Study of Dextransucrase based on the Langmuir Adsorption Isotherm (W Brock Neely and C F Thompson), B A 64
Kinetics Reaction, *review* by Dr T M Sugden, 299
Kinetics of Virus Protein and Ribonucleic Acid Biosynthesis (Replication of Tobacco Mosaic Virus), (Prof Barry Commoner, Dr James A Lippincott and Dr Janey Symington), 1992
Kinetics and Mechanism Behavior of Enzyme Systems, an Analysis of (Dr John M Reiner), *review* by Dr J B Chappell, 388
Kinetics (Chemical), and Reactivity Some Problems in (N N Semenov), Vol I (translated by Michael Boudart), *review* by Dr T M Sugden, 299
Kinetics (Enzyme) Non-Inverted versus Inverted Plots in (Dr B H J Hofstee), 1296 , (Dr Malcolm Dixon and Dr Edwin C Webb), 1298
Kinetin, β-Indoleacetic Acid and Gibberellic Acid Influence of, on Nuclease Activity of Bean (*Phaseolus vulgaris*) Hypocotyls (Dr W Maciekewska-Potapczyk), 557
King, Donald W , and others Unimpaired Mitosis in Cells with Modified Deoxyribonucleic Acid, 1429
King, G A. M (Cummack, C H , and) Disturbance in the Ionospheric *F*-Region following the Johnston Island Nuclear Explosion, B A 32
King, J Colorimetry, *review*, 1522
King, J O L , and others Semi-Albino, a Third Sex-linked Allelomorph of Silver and Gold in the Fowl, 480
King, L A Thermonuclear Research, 1016
King, Dr Philip B The Evolution of North America, *review* by Dr J W Cowie, 1600
King-Hele, D G Prelude to Space Research, *review*, 663
  Russian View of Space Flight, *review*, 836
  Density of the Upper Atmosphere from Analysis of Satellite Orbits—Further Results, 1267
  Jet Propulsion, *review*, 1346
King's College, London Appointment of Prof J L D'Silva to the Halliburton chair of physiology, 322, 405
  Retirement of Prof R J S McDowall from the Halliburton chair of physiology, 405
  Title of reader in applied mathematics in the University of London conferred on Dr C W Kilmister, 1273
  Title of professor of electrical engineering in the University of London conferred on Dr A H M Arnold, 1535
  Title of professor of experimental physics in the University of London conferred on Dr F C Champion, 1613
  Appointment of Dr D R Arthur as reader in zoology, 1613
King's College, Newcastle-upon-Tyne Retirement of Prof J C Prescott from the chair of electrical engineering, 404
  Appointment of Dr R L Russell to the chair of electrical engineering, 404
Kingdom of the Octopus (Frank W Lane), *review* by Anna M Bidder, 218
Kingston, A , and others Ionization Phenomena in Gases (Theoretical Calculation of the 1*s*–2*p* Electron Excitation Cross-section of Atomic Hydrogen), 1354
Kingston Technical College Postgraduate Course of Lectures on Newer Developments in the Chemistry of the Non-Metals, 1915
Kini, M M , and Quastel, Prof J H Carbohydrate—Amino-Acid Interrelations in Brain Cortex *in vitro*, 252
Kinin in Apple Fruitlets (Dr P L Goldacre and Dr W Bottomley), 555
Kino, G S , and Ludovici, B Ionization Phenomena in Gases (Theoretical and Experimental Studies in Plasma Physics), 1357
Kipling, J J , and Wilson, R B Coal Science (Ultra-fine Structure of Coals and Chars—Sorption of Gases and Vapours on Chars prepared by Carbonizing Synthetic Polymers), 413
Kiraly, Dr Z , and others Biochemical Mechanism of Lesion Formation in Virus-infected Plant Tissues, 706
Kirby-Smith, J S Biological Effects of Low Doses of Ionizing Radiations, 1112
Kirk, Prof John E Anticoagulant Activity of Human Arterial Mucopolysaccharides, 369
Kirkham, J H , and others Some Observations on certain Mucoproteins containing Neuraminic Acid, B A 68
Kirkman, Dr Henry N Glucose-6-phosphate Dehydrogenase and Human Erythrocytes—Characteristics of Glucose-6-phosphate Dehydrogenase from Normal and Primaquine-sensitive Erythrocytes, 1291
Kirton, A H , and others Composition of some Fat-free Carcasses and Bodies of New Zealand Sheep, 1724
Kistiakowsky, Dr G B Basic Problems in Propulsion (Solid Propellant Horizons), 779
Kit, Dr Saul Comparative Effects of Heat on Chromatography and Ultraviolet Absorption of Deoxyribo- or Ribo-Nucleic Acids, 36
Kita, Masayoshi (Mitsuki, Chikara, and) Transition of Calcium Sulphate Hemihydrate to Insoluble Anhydrite, 1481
Kittel Prof C Elementary Statistical Physics, *review* by Dr G M Bell, 1178
Kivilaan, Prof Aleksander, and others A Partial Chemical Characterization of Maize Coleoptile Cell Walls prepared with the Aid of a Continually Renewable Filter, B A 81
Klatt, M , and others Coal Science (Carbonization—Studies of the Maceral Species Exinite and Vitrinite by Pyrolysis under High Vacuum), 413
Klausner, Claire, and others Phenazine Di-*N*-Oxide as a Carcinostatic Agent, 908
Klavins, Margaret, and others Two Enzymic Mechanisms for Hydrogen Transport by Phenolic Œstrogens, 427
Klein, Prof A Nuclear Forces and the Few-Nucleon Problem (Photonuclear Reactions with Light Nuclei), 1114
Klein, Dr George The Structure of Science (Evolution of Tumour Cell Populations), B A 8
  Awarded a grant by the Lady Tata Memorial Trust, for research on Leukaemia and allied Diseases, 507
Klein, Dr Louis River Pollution, 1, Chemical Analysis, *review* by Prof R Belcher, 1177
Klement, Z Some New Specific Bacteriophages for Plant Pathogenic *Xanthomonas* spp , 1248
Klemm, Friedrich A History of Western Technology (translated from the German by Dorothea Waley Singer), *review* by K B Gilbert, 1601
Klemperer, D F (Anderson, Prof J S , and) 'Thermal Regeneration' in the Nickel–Oxygen System, 899
Klerk, M Ionization Phenomena in Gases (Striations in the Positive Column of Glow Discharges), 1355
Klingmuller, Dr W , and others Free Radicals in X-Rayed Seeds of High and Low Water Content, as Measured by Electron Spin Resonance, 464
Klyne, Dr W , and others Optical Activity of Stercobilin and *d*-Urobilin, 41
Klyne, Dr W (Neuberger, Prof A , and) Steric Aspects of the Chemistry and Biochemistry of Natural Products, 947
Kmentova, Dr V (Schreiber, Dr V , and) Effects of Methylthiouracil or Thyroidectomy on Activation of Pituitary Acid Phosphatases *in vitro* by Whole Hypothalamic Extract, 728
Knapp, Prof B R The British Food Manufacturing Industries Research Association, 1275
Knapp, Dr V Appointed Research Fellow in nuclear physics in the University of Birmingham, 1915
Kneubuhl, Dr Fritz Awarded a Swiss Fellowship in Chemistry for 1959-60 by the Ramsay Memorial Fellowships Trustees, B A 16
Knight, C S A New Two-Dimensional Paper Chromatographic Method applied to the Separation of Amino-acids, 1486
Knight, J J (Coles, Surg Lieut R R A , and) Effect of Jet Aircraft Noise on Hearing, 1803
Knight, K , and others Pleistocene Climatic Significance of Calcretes and Ferricretes, 568
Knight, M At the Conference of the Mammal Society of the British Isles (The Food of the Water Vole and Harvest Mouse), 30
Knisely, Prof M H Flow Properties of Biological Systems (Film to illustrate work on 'Sludged Blood'), 1540
Knobloch, Dr Eduard Isomeric O-Methyl Ethers of Ethyl di-(4-hydroxycoumarinyl-3)-Acetate (the Anti-coagulant Drug Pelentane or Thromexane), 1568
Knoll, Prof M , and Kugler, J Subjective Light Pattern Spectroscopy in the Encephalographic Frequency Range, 1823
Knowing and Being (British Society for the Philosophy of Science Symposium on), 1193
Knowles, Sir Francis (Dr Carlisle, David B , and) Endocrine Control in Crustaceans, *review* by Prof J H Welsh, 1761
Knowles, Dr Roger, and Laishley, Edward Factors in Forest-Tree Litter Extracts affecting the Growth of Soil Micro-Organisms, 1169
Koch, Prof H J , and others Sodium Regulation in the Blood of Parr and Smolt Stages of the Atlantic Salmon, 283
Koch, Dr J H , and Gallagher, Dr C H Effect of some Neuromuscular Blocking Agents on Mitochondrial Enzyme Systems, 1039
Kochetkova, G V , and others Rate of Appearance of Mutants with Respiration-deficiency in *Staphylococci* 1821
Kock, Nils G Reflex Inhibition of Intestinal Motility, 1069
Koda, Shigeyasu (Watanabe, Ryoji, and) Reversion of Nodules formed by the Grain Boundary Reaction in Aluminium–Zinc Alloys, 977
Kodak Scholarships in Colour Photography (Kodak, Ltd), 1915
Koepcke, Dr Hans-Wilhelm Beitrage zur Kenntnis der Fische Perus, II (Beiträge zur Neotropischen Fauna), *review* by Dr F A Turk, 1177
Koepcke, Dr Hans-Wilhelm (herausgegeben von Prof Dr Erich Titschack und) Beitrage zur Neotropischen Fauna Band I, Heft 3, Zur Kenntnis der Pseudoscorpioniden-Fauna des Andengebietes (Max Beier) , Kritische Untersuchungen der Newportia-Arten (Wolfgang Bucherl) , Ein neuer *Asthenes* (Aves, Furnariidae) von der Kuste und

dem westlichen Andenabhang Sudperus (Maria Koepcke) , Beitrage zur Kenntnis der Fische Perus, II (Hans-Wilhelm Koepcke), *review* by Dr F A Turk, 1177
Koepcke, Maria Ein neuer *Asthenes* (Aves, Furnariidae) von der Kuste und dem westlichen Andenabhang Sudperus (Beitrage zur Neotropischen Fauna), *review* by Dr F A Turk, 1177
Kogl, Prof F *Obituary* by Prof G J M van der Kerk, 1609
Kohiyama, M , and Ikeda Y Anomalous Genetic Interactions observed in *Bacillus subtilis*, 208
Kohler, Max A Design of Hydrological Networks (World Health Organization, Technical Note No 25), 96, *erratum*, 684
Kohn, Dr H I , and Guttman, Dr P H Latent Period of X-Ray Induced Ageing—a Study based on Mortality Rate and Tumour Incidence, 735
Kohn, Harold W Colour Centres produced by Radiation in Silica Gel, 630, *erratum*, 1026
Kohoutova, Dr M Immunization with Biologically Active Fractions of Deoxyribonucleic Acid and Subsequent Specific Infection of Mice, 1965
Koizumi, Masao (Kato, Shunji, and) Reductive Photo-bleaching of Eosine—Primary Processes indicated by the Flash Technique, 1620
Koizumi, Masao, and others Reductive Photo-bleaching of Eosine—Effect of Added Substances on the Rate of Reductive Photo-bleaching, 1620
Koketsu, L (Abood, L G , and) Excitability and Phosphorylation of Muscle and Nerve in Sodium-free Hydrazinium Solution, 725
Kolb, A C Ionization Phenomena in Gases (Recent Progress in Shock Wave Research), 1356
Kolb, A C (Griem, H R , and) Ionization Phenomena In Gases (Improved Methods of Calculating Stark Broadening of Spectral Lines), 1357
Kolbuszewski, Dr J Appointed to the chair of highway and traffic engineering in the University of Birmingham, 939 , work of, 939
Koldovsky, O , and others Passage of Insulin through the Wall of the Gastrointestinal Tract of the Infant Rat, 1245
Koller, P C , and Doak, S Biological Effects of Low Doses of Ionizing Radiations (Immunological Aspects of Tissue Transplantation after 300 r of X-Rays), 1113
Kolmogorov, A N Elected an Honorary Member of the American Academy of Arts and Sciences, 410
Kolsky, Dr H Atomic Mechanisms of Fracture (Similarities in Behaviour of Plastics and Viscous Liquids when subjected to Tensile-stress Pulses of Short Duration), 324
Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 858 , work of, 858
Elected president for 1959-60 of the British Society of Rheology, 943
Kolstad, Knut *Patella aspera* Lamarck, New to Norway, 1886
Komarewsky, V I , and others (edited by) Advances in Catalysis and related Subjects, Vol 10, *review* by Dr F S Stone, 1974
Komelkov, V S , and others Ionization Phenomena in Gases (A Dynamically Stable Current Column), 1357
Komesu, Dr Nathan, and others Prophylactic Effects of Amine Oxides in Radiation Injury in Mice, 198
Kongwa and Nachingwea Districts of Tanganyika Survey of Soils in the (B Anderson), *review* by Dr R M S Perrin, 1901
Konieczna-Marczynska, Barbara (Skowron-Cendrzak, Anna, and) Skin Homografts in Parabiotic Mice, 1590
Konno, Dr Kiyoshi, and others Nicotinamidase in *Mycobacteria*—a Method for Distinguishing Bovine Type Tubercle Bacilli from other *Mycobacteria*, 1743
Konogi, Hiroshi, and others Occurrence of Polynucleotide Phosphorylase in Atypical Epithelioma of Rat, 1939
Konoval, G , and others X-Ray Diffraction Pattern of Carbide in Low-Carbon Iron-Silicon Alloys, 1862
Koornhof, H J (Bokkenheuser, V , and) Interaction of Erythrocytes and Endotoxins, 109
Koprowski, Dr Hilary The Structure of Science, B A 9
Awarded the Alvarenga Prize for 1959 by the College of Physicians of Philadelphia, 683
Koprowski, Dr Hiliary (Billingham, Dr R E , and) The Wistar Institute of Anatomy and Biology, Philadelphia, B A 6
Koprowski, Dr Hilary (Defendi, Dr V , and) Influence of Adult Lymphoid Tissues on Polyoma-induced Tumours, 1579
Korenchevsky, Dr V *Obituary* by Prof P L Krohn, 231
Kornberg, Prof A Nobel Prize for Medicine for 1959 divided between Prof S Ochoa and, 1021 , work of, 1021
Koryta, Jiri Fast Chemical Reactions in Solution (Use of Polarographic Technique in the Study of Electrode Reactions), 1453
Koshimizu, Koichi, and others Plant Growth Activities of 5- and 8-Halogeno- Dihydro- and Tetrahydro-1-naphthoic Acids, 1415
Kossack, Dr Carl F Appointed manager of the newly formed Statistics and Operations Research Department of International Business Machines Corporation at the Lamb Estate Research Center, Cortlandt, N Y , 410
Kostick, E L , and others Stone Implements from Western Nigeria, 124
Kotnis, L B , and others Inhibition of Tumour Growth with 2 5-Dicarbethoxy-3 4-Dihydroxy-Thiophene, 201
Kout, Dr M , and Kubickova, Dr Z Influence of Streptomycin Solutions on the Interaction between the Agglutinating Sera and the Corresponding Red Blood Cell Receptors, 639
Kozyrev, N A Volcanic Activity on the Moon, 856
Krakoff, Dr Irwin H , and others Reversal of Effects of 2-Substituted Thiadiazoles by Nicotinamide Analogues and Precursors, 1805
Kralik, O , and others An Electron-Microscopic Study of Spores of Morphological Variants of *Streptomyces erythreus* Strains, 1888
Kramer, Dr Gustav J *Obituary* by Dr D B Carlisle, 22
Kramp, P L The Hydromedusae of the Atlantic Ocean and adjacent Waters (*Dana* Report No 46), *review* by J H Fraser, 300
Kratky, Prof Otto Elected a member of the Physics Section of the Leopoldina Academy of Natural Sciences, 595
Kraus, Prof John D (Crone, W Reed, and) Apparent Observations of Solar Corpuscular Clouds by Direct Continuous—Wave Reflexion, 965
Kraus, Prof John D The Ohio State University 360-ft Radio Telescope, 669
Krauss, Dr W Polar Front Survey (Hydrography—North Atlantic Ocean), 1182
Krebs, H Macromolecules (Inorganic and Organic/Inorganic Polymers), 1690
Krebs Cycle Acids Oxidation of, by Apple Tissue (M D Hatch, J A Pearson, A Millerd and R N Robertson), 506
Kremer, Henry Prize of £5,000 for the first successful flight of a Man-powered Aircraft, 1534
Kremer, Dr Mordechai L Oxidation of Ethyl Alcohol by a Mixture of Hydrogen Peroxide and Ferric Salts, 720
Krige, Dr G J R , and others Evidence for a Hydrate of Cellulose from Studies of its Surface Properties, 1561
Krishnamurthy, B S (Pal, R , and) Induced Mutations of X-Ray Irradiations in *Culex fatigans* Wied (1828), 658
Krishnaswamy, S , and Munday, K A At the Conference of the Mammal Society of the British Isles (Filter-paper Electrophoresis on Blood Serum from various Murids), 30
Kristoffersson, Dr R , and others Release of Adenosine Triphosphate and Serotonin from Injured Cellular Blood Elements in Extracorporeal Circuits, 1127
Kritchevsky, David, and others Effects of Deuterium Oxide on the Synthesis of *T5* and *T7* Bacteriophages, 1167
Křivsky, L (Gregor, Z , and) Changes in the Climate of the Atlantic–European Area and Secular Solar Activity, 682
Kroger, C , and others Coal Science (Carbonization—Studies of the Maceral Species Exinite and Vitrinite by Pyrolysis under High Vacuum), 413
Krohn, Prof P L *Obituary* of Dr V Korenchevsky, 231
Kroon, D J , and Stolpe, C v d Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Kroone, B (Cole, W F , and) Carbonate Minerals in Hydrated Portland Cement, B A 57
Kruissink, C Macromolecules (Theory of using Membranes partially Permeable to the Solute), 1689
Kubaschewski, Dr O Thermodynamics (Experimental Thermochemistry), 1607
Kubaschewski, Dr O , and Evans, E Ll Metallurgical Thermochemistry, *review* by Dr F C Thompson, 1765
Kubickova, Dr Z (Kout, Dr M and) Influence of Streptomycin Solutions on the Interaction between the Agglutinating Sera and the Corresponding Red Blood Cell Receptors, 639
Kublik, Zenon, and others Influence of Gold in a Mercury Electrode on certain Electrode Processes, B A 56
Influence of Platinum in Mercury on the Mechanism of Electrode Reactions at the Mercury Electrode, 1795
Kuchela, K N (Birks, Dr J B , and) Energy Transfer with special reference to Biological Systems (Polystyrene Solutions as a Function of Wavelength), 689
Kudrjashov, Prof B A Interrelations between the Blood Coagulating System and the Physiological Anticoagulating System, 454
Kugler, J (Knoll, Prof M , and) Subjective Light Pattern Spectroscopy in the Encephalographic Frequency Range, 1823
Kugler, J H (Harris, P F , and) Cells which Synthesize Deoxyribonucleic Acid in Guinea Pig Bone Marrow during Recovery from Whole-body γ-Irradiation, 1883
Kuhn, Jeanne, and others Ribonucleases of Mouse Tissues and of the Ehrlich Ascites Tumour, 984
Kuhn, W Macromolecules (Production of Mechanical Energy by Macromolecular Systems), 1690
Kulonen, E (Hakkinen, Dr H -M , and) Increase in the γ-Aminobutyric Acid Content of Rat Brain after Ingestion of Ethanol, 726
Kulp, Prof J Laurence, and others The Geological Time-Scale, B A 62
Kumar, S A , and others Biochemical Research in India (Occurrence of Flavin Nucleotides in Plants and the Changes in their Concentration with Germination of Green Gram and Cow Pea), 1368
Kunin, Robert Ion Exchange Resins, second edition, *review* by D Reichenberg, 1757
Kunz, Lawrence J , and others Distribution of 5-Carboxymethylhydantoinase, 1314
Kupcik, Vladimir, and Durovic, Slavomil Influence of the Size of the Halogen Atom on the Difference between Lattice Constants of Copper dipyridine dichloride and dibromide, 1060
Kuprianova, L A Origin and Dispersal of Flowering Plants (Palynological Studies suggested that *Liquidambar* already occurred in the Upper Cretaceous), 1201
Kurdjumov, Academician G V The Phenomena occurring in Steels during Quenching and Tempering (Hatfield Memorial Lecture), 1450
Martensitic Transformations in Metals and Alloys, 1450
Kuroda, Dr Yukiaki (Horikawa, Dr Masakatsu, and) *In vitro* Cultivation of Blood Cells of *Drosophila melanogaster* in a Synthetic Medium, 2017
Kuwabara, M , and Naka, K Response of a Single Retinula Cell to Polarized Light, 455
Kuwajima, Yoshio (Matsui, Prof Toshitaka, and) Formation of the Toxoid of Histamine Sensitizing Factor in *Bordetella pertussis*, 199
Kuzmanova, P , and others Agar Electrophoresis of Normal Soluble Proteins in Guinea Pig Liver, B A 64
Kwashiorkor Blood Keto-Acids in (Prof J C Edozien), 1150
Changes in the Level of Serum Protein during Treatment of (Dr Olumbe Bassir), 2019
Kwiek, Stanislaw (Tysarowski, Wieslaw and) Difference between the Catalases of Acid-fast Bacilli, 1513
Kynch, Prof G J Sedimentation and Effective Viscosity, 1311

LAASIMER, L Origin and Dispersal of Flowering Plants (Division of the Flora of Estonia into East Baltic related to Eastern Europe and West Baltic to Central Europe), 1200
Labelled Magnesium Excretion o , by the Sheep (D C Macdonald, A D Care and B Nolan), 736
Labelling of Rose Bengal with Iodine-131 by Radioactive Exchange (J Liebster and O Andrysek) 913
Labelling (*In vitro*), of Antibody Globulin by Tritium Exchange (Dr P C Rajam and Anne-Louise Jackson), 375
Lability of Fibrinolysin (Prof Murray Weiner), 1937
Laboratories (New Research), for the Cambridge Instrument Company Ltd (Dr M C Marsh), 1364

Laboratories (Physics Research) The Design of—a Symposium of the London and Home Counties Branch of the Institute of Physics (London, 1957), *review* by S Weintroub, 925

Laboratory (Regional Research), Hyderabad Annual Report for 1957-58, 320

Laboratory Cats Reduction in the Anoestrus Period of, by Increased Illumination (Dr Patricia P Scott and Marny A Lloyd-Jacob) 2022

Laboratory Data Biological (Dr L J Hale), *review* by Prof R C McLean, 577

Laboratory Equipment Hot (United States Atomic Energy Commission), new edition, 155

Laboratory Mammals Visual Pigments of some Common (Dr C D B Bridges), 1727

Laboratory Media Production of Fungal Arbuscular Organs on (G A Atkins), 1738

Laboratory Technicians Regional Training Course for (University Institute of Chemistry, Lahore), 857

Labour and National Service, Ministry of Report of an inquiry by the National Joint Advisory Council into the Efficient Use of Man-power in Industry, 25
  Guides to Official Sources, No 1, Labour Statistics, B A 15
  Annual Report, 854
  Annual Report of the Chief Inspector of Factories on Industrial Health for 1958, 1023
  Annual Report of the Chief Inspector of Factories for 1958, 1456

Labour and National Service, Ministry of (British Institute of Management and the) Conference on Relationships in Industry—some Changing Concepts of Management, 156

Labour Statistics (Ministry of Labour and National Service, Guides to Official Sources, No 1), B A 15

Labour Turnover (T H Hawkins), 1110

Labour Turnover Cost of (British Institute of Management), 1110

Laby, R H (Hambly, Prof A N, and) At the Second Australian Spectroscopy Conference (Criteria for Allocating Displacements of X—H Bond Stretching Frequencies to the Formation of Hydrogen Bonds), 1196

Lacey, B W (edited by A Isaacs and) Virus Growth and Variation—Ninth Symposium of the Society for General Microbiology, London, 1959, *review* by N W Pirie, 920

Lacey, Dr William S Occurrence of Presumed Glossopteridean Fructifications in Rhodesia and Nyasaland, 1592

Lack, Charles H *Obituary* of Dr E S Duthie, 589

Lack of Direct Effect of Erythropoeitin on Human Erythroid Cells *in vitro* (Edward L Alpen, L G Lajtha and Donald C Van Dyke), 1228

Lacon, Corrine R, and others Reversal of Effects of 2-Substituted Thiadiazoles by Nicotinamide Analogues and Precursors, 1805

Lactobacillus pastorianus var *quinicus* Metabolism of Cinnamic Acid and Hydroxy-Cinnamic Acids by (Dr G C Whiting and Dr J G Carr), 1427

Lactone (DL-[2-^{14}C] Mevalonic Acid) Incorporation of, into Polyisoprene (R G O Kekwick, B L Archer, D Barnard, G M C Higgins, G P McSweeney and C G Moore), 268, *erratum*, 772

Lactose Significance of, in the Diet in Aminoaciduria caused by Maleic Acid (Stefan Angielski and Jerzy Rogulski), 276

Lactose Labelled with Carbon-14 Preliminary Observations on the Fate of Intravenously Administered (Dr Frederick J Carleton and Dr Henry R Roberts), 1650

Lactose (Potassium and), in Milk in relation to the Physiology of Milk Secretion (Dr J A F Rook and Marian Wood), 647

Lacuara, Jorge L, and others The C_{17}-OH Group of Œstradiol—Relationships between its Anti-Atherogenic and Endocrine Actions, 1720

Lacunal Parenchyma of *Mimosa pudica* Changes in the, In Diurnal and Nocturnal Conditions (Hideo Toriyama), 737

Lacy, Dr D (Smith, B V Kingsley, and) Residual Bodies of Seminiferous Tubules of the Rat, 249

Ladam, A, and Payen, P Coal Science (Ultra-fine Structure of Coals and Chars—Sorption of Pyridine by Carbonization Products), 413

Ladbury, Dr J W Oxidation of Organic Compounds (Oxidation of Inorganic and Organic Compounds by Permanganate), 326

Ladik, J, and Szekacs, Dr I A Micromethod for the Polarographic Determination of Serine, 188

Ladner, W R, and others Coal Science (Data obtained on Coal by High-resolution Magnetic Resonance Spectroscopy), 412

Lahaye, Prof E Réalisation du Centre de Physique du Globe a Dourbes, 1022

Lahlouh, B, and others Natriferin, a New Hormonal Principle in the Neurohypophysis of certain Vertebrates, 1236

Laine-Boszormenyi, M, and others Low-Temperature Autoradiography for the Detection of Tritium in Tissue, with Removal of Luminescence induced by Tritium, 1385

Laishley, Edward (Knowles, Dr Roger, and) Factors in Forest-Tree Litter Extracts affecting the Growth of Soil Micro-Organisms, 1169

Lajtha, Dr L G, (Oliver, R, and) Biological Half-Life of Radioiron in Man, 1882

Lajtha, Dr L G (Pirie, A, and) Possible Mechanism of Cysteine Protection against Radiation Cataract, 1125

Lajtha, Dr L G, and others Lack of Direct Effect of Erythropoietin on Human Erythroid Cells *in vitro*, 1228

Lake District, Friends of the Annual Report, 1844

Lakes (Great) Geology of the (Prof Jack L Hough), *review* by Prof S E Hollingworth), 665

Lalor Foundation Awards for 1960, 684

Lamb, D C, and others Biological Origin and Configuration of 10-HydroxyΔ^2-decenoic Acid, 634

Lamb, J Fast Chemical Reactions in Solution (Use of the Ultrasonic Technique to Study Rotational Isomerizations), 1453

Lamb, Prof W E Experimental Tests of Quantum Electrodynamics (Guthrie Lecture of the Physical Society), 954

Lambe, Ronan F Awarded a junior post-graduate agricultural research scholarship by An Foras Taluntais (the Agricultural Institute of Ireland), 1612

Lambert, D G Animals In Hiding (Christmas Lecture at the Zoological Society of London), 1535

Lambs Growth Responses to Selenium in (Dr J W McLean, G G Thomson and J H Claxton), 251

Lambs on a Diet containing Roughage Experimental Production of Magnesium Deficiency in (Dr D M McAleese and Dr R M Forbes), 2025

Lamellibranch Molluscs Evidence for a Sliding Filament Contractile Mechanism in Tonic Smooth Muscles of (Dr Jean Hanson and Dr J Lowy), 286

Laminar Structure (A Dense), found in Conjunction with Cell Membranes in the Anterior Pituitary Gland (Barbara G Barnes), 651

Lamming, Dr G E Appointed to a readership in animal physiology in the University of Nottingham, 410

Lamont, P H Awarded a Wellcome Fellowship by the Animal Health Trust, 771

Lampreys Speciation among (Dr Giuseppe Zanandrea), 380

Lancashire Livestock Farming in the Great Depression (T W Fletcher), 1916

Lance, Dr G N At the Annual General Meeting and Conference of the Mathematical Association (The *Pegasus* Digital Computer at the University of Southampton), 33

Land in the Victorian Period Free Trade in (O R McGregor), 1916

Land of Britain—is it Used to the Best Agricultural Advantage ? (Association of Agriculture and the Extra-Mural Department of the University of London Lectures on), 1845

Land and in the Oceans Plants on (Dr W R G Atkins), B A 46

Land and Water Bugs of the British Isles (Dr T R E Southwood and Dennis Leston), *review* by W J Le Quesne, 1977

Land-Use Planning More (Prof L Dudley Stamp), 27

Land Use Policy in Tropical Catchment Areas A Physical Basis for (Dr H C Pereira), 1768

Land-Use Surveys of the Regional Research Centre of the British Caribbean Soil and—No 1, Parish of St Catherine, Jamaica (K C Vernon), No 2, The Rupununi Savannas of British Guiana (R F Loxton, G K Rutherford and J Spector), No 3, St Vincent (J P Watson, J Spector and T A Jones), 27

Landa, S Coal Science (Chemical Reactions of Coal Hydrogenation of Model Substances, Montan Wax and Humic Acids extracted from Brown-coal), 413

Landau, L D, and Lifshitz E M Statistical Physics (translated from the Russian by E Peierls and R F Peierls), *review* by Dr H Steeple, 664

Landauer, Prof Walter (de Franciscis, Dr Pietro, and) Combined Effects of Cortisone and Insulin on Developing Chicken Embryos, 101

Landesman, A Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158

Landmark, B Fluctuation Phenomena and Stochastic Processes (Test for the Gaussian Character of a given Noise Signal), 510

Landmark, B, and others The D Region of the Ionosphere, 973

Landsberg, Dr P T Appointed to the newly created chair of applied mathematics in University College, Cardiff, 591, work of, 591

Lane, Dr A M Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 859, work of, 859

Lane, Frank W Kingdom of the Octopus, *review* by Anna M Bidder, 218

Lane, Dr G R, and others Free Radicals in X-Rayed Seeds of High and Low Water Content, as Measured by Electron Spin Resonance, 464

Langer, Dr S H Gas Chromatography (Improvement in Stationary Phase Selectivity), 328

Langerhans (Islets of) Actual Distribution of the Number and Volume of the, in Different Size Classes in Non-diabetic Humans of Varying Ages (Bo Hellman), 1498

Langford, W J Statistical Methods, *review*, 1523
  Obituary of A W Siddons, 1684

Langford, W J, and Vaughan, D J Separation of Polyvinyl Chloride and Polyvinyl Acetate by Chromatographic Methods, 116

Langmuir Adsorption Isotherm Kinetic Study of Dextransucrase based on the (W Brock Neely and C F Thompson), B A 64

Langstroth, G F O Awarded an Overseas Scholarship by the Royal Commission for the Exhibition of 1851, 409

Language Classification, Concept-formation and (British Society for the Philosophy of Science Symposium on), 1193

Lapage, Dr Geoffrey Parasitic Animals, second edition, *review* by Dr C A Wright, 1011

Lapresel, Dr C, and others Immunochemical Studies of Polypeptidyl Proteins and Synthetic Polypeptides, 549

Lapworth, K C Thermonuclear Research (Shock Waves in Gases), 1018

Lardy, Henry, and others (edited by) The Enzymes, Vol 1, Kinetics, Thermodynamics, Mechanism, Basic Properties, second edition, *review* by Dr Edwin C Webb, 1759

Large Heavily Sclerotized Whole Insects Sectioning (Prof W E Beckel), 1584

Large Intestine of the Calf Absorption of Magnesium in the (Dr R H Smith), 821

Larikov, G Primer Explosion Triggers Reaction, 447

Larke, Sir William *Obituary* by Guy Parsloe, 21

Larkin, Lois, and others Failure to Recover Infective 'Ribonucleic Acid' from Myxovirus Preparations, 360

Larminie, Helen E, and others Effect of Oxygen Tension on Haem and Porphyrin Biosynthesis, 1217

Larsen, Dr J A Extrahepatic Metabolism of Ethanol in Man, 1236

Larsen, Kai Cytology of the Genus *Sanguisorba*, 743

Larvae (Acraniate) Ecology of (J H Wickstead and Quentin Bone), 1849

Larval and Pupal Periods of some Lepidopterous Insects Relationship between (Dr M A Zaher and Dr Moufied A Moussa), 288

Lasnitski, Dr Ilse Cell and Organ Culture (Application of Cell and Organ Culture in Cancer Research), 936

Lassen, Dr Knud Existence of an Inner Auroral Zone, 1373

Lassen, Dr Ulrik V (Overgaard-Hansen, Dr Kay, and) Active Transport of Uric Acid through the Human Erythrocyte Membrane, 553

Lasslo, Dr Andrew, and Meyer, Anne L Effect of Chlorpromazine upon Isolated *d*-Amino-Acid Oxidase Systems, 1922

Late-Glacial (Irish) *Lepidurus arcticus* in the (Dr M E S Morrison), 739

Late Pre-Cambrian Ice Age Palaeomagnetism in some Norwegian Sparagmites and the (W B Harland and D E T Bidgood), 1860

Latent Period of X-Ray Induced Ageing—a Study based on Mortality Rates and Tumour Incidence (Dr H I Kohn and Dr P H Guttman), 735

Lateral Muscle (Red), of Rainbow Trout Changes in Purine Nucleotides of (Tsuneyuki Saito, Ken-ichi Arai and Toshikatsu Yajima), 1415

Lateral Nasal Gland (Salt Gland) Captive Marine Birds possessing a Functional (Prof Larry Z McFarland), 2030
Latex (*Hevea*) Ultracentrifugation and Staining of (G F J Moir), 1626
Latham, Dr R Thermonuclear Research in Great Britain, 1015
Lathyrus odoratus L Sterility in (Dr J R Ellis and M A Burton), 204
Latin in University Entrance Requirements 297
Lattice Constants of Copper dipyridine dichloride and dibromide Influence of the Size of the Halogen Atom on the Difference between (Vladimir Kupcik and Slavomil Durovic), 1060
Lattice Spacings and Structures of Metals and Alloys A Handbook of (Dr W B Pearson), *review* by Dr J A Catterall, 841
Latty, James E, and Clark, Dr W C Forces between Titanium Dioxide Pigment Particles, 49
Lauer, Dr E Thermonuclear Processes (Magnetic-Mirror Method of Confinement), 241
Lauffer Max A (edited by Kenneth M Smith and) Advances in Virus Research, Vol 6, *review* by N W Pirie, 920
Laurence, G S General Fellowship in Chemistry renewed by the Ramsay Memorial Fellowships Trustees, B A 16
Lauwers, A, and others Influence of X-Rays on the Activity of Carbonic Anhydrase in Erythrocytes and on their Haemolytic Resistance, 111
Laven, H Cytoplasmic Inheritance (Interracial (Geographical) Crosses in *Culex pipiens*), 1012
Laves, Prof F Alpine Mineral Fissures (Feldspars of the Alpine Fissures and their Twinning), 1910
Lavoipierre, M (Gordon, R M, and) Delayed Hypersensitivity (Immediate and Delayed Reactions to Insect Bites), 1030
Law, Lloyd W, and others Antibody Status of Mice and Response of their Litters to Parotid Tumour Virus (Polyoma Virus), 1420
Law The Economics of Nuclear Power, including Administration and (edited by I R Maxwell P W Mummery and Philip Sporn), Vol 2, *review* by R Brightman, 1673
  Periodic (D I Mendeleieff), edited by B M Kedrov (Russian Text), *review* by Prof S I Tomkeieff, 1598
Lawley, A Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Preliminary Work on Molybdenum–Rhenium Alloys), 691
Lawrence, B G Heating and Ventilation (Engineering Approach to Air Conditioning), 1987
Lawrence, H S Delayed Hypersensitivity, 1029
Lawrence, John H (edited by Cornelius A Tobias and) Advances in Biological and Medical Physics, Vol 6, *review* by Dr N M Blackett, 1766
Lawrie, J A, and others Magnetic Effects resulting from Two High-Altitude Nuclear Explosions B A 34
Laws, Dr J O, and Stickland, Dr L H Changes in Adenosine Di- and Tri-phosphate Concentrations in the Early Stages of the Action of Yeast on Glucose, 1246
Lawson, D D At the Eleventh Annual Convention of the Canadian Veterinary Medical Association (Thoracic Surgery), 696
Lawson, G J, and Ward, S G Coal Science (Chemical Reactions of Coal—Chromatographic Separation of Oxidation Products of Coal), 413
Lawson, J D, and others A Revised Classification of the Ludlovian Succession at Ludlow, 1037
Lawton, B T Awarded a Perkin Centenary Scholarship, 237
Layman Astronomy for the, 1913
Layrisse, Dr Miguel, and de Layrisse, Dr Zulay Frequency of the New Blood Group Antigen Js^a among South American Indians, 640
Layton, J M Modern Network Theory in Electrical Engineering (Networks with Parameters varying with Time), 1691
Lazzarini, E, and others Rôle of Stroma in Haemoglobin Synthesis—Experiments on Duck Red Cells *in vitro*, 1878
  Pathway of Carbon-^{14} Incorporation from $NaH^{14}CO_3$ to Haem in Duck Blood incubated *in vitro*, 1879
le Couteur, P Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Horizontal Zone-melting to Purify Germanium), 692
Le Quesne, W J Land and Water Bugs of the British Isles *review*, 1977
le Roux, P L Routine Methods for Determining Quality in Merino Wool, 917
Leach, K, and others Electron Spin Resonance Investigations of *Allium cepa* and *Calliphora vomitoria*, 1402
Leach, S J, and Swan, J M Structure and Chemistry of Proteins (Chemistry of Thiols and Disulphides), 1277
Lead (Zone-Refined) Recrystallization of (G F Bolling), 718
Lead Oxalate (Irradiated) Thermal Decomposition of (P J Herley and E G Prout), 445
Lead-tolerant Population of *Agrostis tenuis* Adaptation of a, to Low Soil Fertility (D Jowett), 43
Leadbetter, E R, and Foster, J W Incorporation of Molecular Oxygen in Bacterial Cells utilizing Hydrocarbons for Growth, 1428
Leadership (Creative), in a State Service—a General Survey (Sir George Schuster), (Hospitals and the State—Hospital Organization and Administration under the National Health Service, Sixth and Final Research Report), 1087, 1201
Leaf of *Camellia japonica* Pattern and Control of Sclereid Formation in the (Donald E Foard), 1663
Leaf (Tobacco), and Tobacco Smoke Composition of a Paraffin Wax Fraction from (Dr W Carruthers and Dr R A W Johnstone) 1131
Leaf Cells (Tobacco), capable of Supporting Virus Multiplication Isolation of (Prof Milton Zaitlin), 1002
Leaf Size in Gramineae Inflorescence Inception and (M Borrill), 321
Leake, Prof Chauncey D, and others Statement on Biological and Chemical Warfare, 1018
Leakey, Dr L S B A New Fossil Skull from Olduvai, 491
Learned and Professional Societies in Britain Taxation of, 1343
Learning Perception and, *review* by Prof O L Zangwill, 1523
  The World of, 1958-59, ninth edition, *review*, 489
Learning in Two Towns After Work—Leisure and (R Ruddock and Dr A Wilson), 1034
Learning (Free) A Defence of (Lord Beveridge), *review* by R Brightman, 576
Least-Squares Solution for a Linear Relation between Two Observed Quantities (P A Wayman), 77, (B K Kelly), 1086
Leather Trades' Chemists Society of The Chemistry of Vegetable Tannins—Being the Papers presented at a Symposium held in the University, Cambridge, 1956, *review* by Dr A I Scott, 1832
Leaves of *Acer saccharinum* L Formation of Allantoin and Allantoic Acid from Adenine in (Robert L Barnes), 1944
Leaves of Long Shoots of *Ginkgo biloba* Vein Anastomoses in the (Dr Howard J Arnott), 1336
Lebedinsky, V I Liquation Differentiation in Magma, 1025
Leaves of some Plants Distribution of Ascorbic Acid in the (Dr Philippe Hagene), 284
Leck, Dr V H Appointed to a senior lectureship in electronic engineering in the University of Liverpool, 410
Lectures on the Land of Britain—is it Used to the Best Agricultural Advantage ? (Association of Agriculture and the Extra-Mural Department of the University of London Course of), 1845
Lectures on Newer Developments in the Chemistry of the Non-Metals (Kingston Technical College Course of), 1915
Lectures and Practical Work on Micro- and Semi-microchemical Methods (Norwood Technical College Course of), 1845
Lectures (University) Visual Illustration of (British Universities Film Council Discussion on), 515
Leddicotte, G W Radioactivation Analysis (Recent Developments in the United States), 951
Lederer, Prof E, and others Isolation of 24-Methylene-cholesterol from Honey Bees (*Apis mellifica* L), 732
Lederer, Prof E (Gastambide-Odier, Dr Mireille, and) Biosynthesis of Corynomycolic Acid from Two Molecules of Palmitic Acid, 1563
Lederer, Michael Chromatographic Reviews—Progress in Chromatography, Electrophoresis and related Methods, Vol 1, *review* by Dr R Consden, 1436
Ledger, H P A Possible Explanation for Part of the Difference in Heat Tolerance Exhibited by *Bos taurus* and *Bos indicus* Beef Cattle, 1405
Lee, A J, and Cushing, Dr D H International Council for the Exploration of the Sea—Special International Geophysical Year Meeting, 1180
Lee, Dr E W Appointed lecturer in physics at the University of Sheffield, 684
Lee, Prof Frank A A Chemical Effect of Ethylene during the Storage of Peas, 462
Lee, G E, and others Congeners of Pempidine with High Ganglion-blocking Activity, 1707
Lee, G W Work carried out at the Coke Research Centre, 1778
Leech, J Appointed lecturer in the computing laboratory in the University of Glasgow, 1915
Leeds Some Measurements of Background Gamma-Radiation in, during 1955-59 (Prof F W Spiers,, 1680
Leggiero, G (Bolcato, V, and) Glycolaldehyde Trapped from Aerobic Oxidation of D-Xylose by *Torulopsis utilis*, 1318
Legumes Gibberellic Acid and Nodulation of (Dr Wm W Fletcher, J W S Alcorn and J C Raymond), 1576
  Influence of Temperature on the Symbiotic Nitrogen Fixation of (the late Prof Margaretha G Mes), 2032
Lehman, L Appointed lecturer in dental mechanics and prosthetics at the University of Sheffield, 584
Lehmann, Dr H (Hunt, Dr J A, and) Haemoglobin 'Bart's', a Foetal Haemoglobin without α-Chains (Abnormal Human Haemoglobins), 872
Lehmann, Dr H, and others Haemoglobin P in a Family in the Belgian Congo, 1133
Lehmann, Dr M At the first Conference of the British Computer Society (Very Fast Computers), 945
Leibowitz, Prof Jeshaia (Shasha, Baruch, and) Oleuropeic Acid, a New Compound from *Olea europaea*, 2019
Leicester, Henry M (edited by) Chymia—Annual Studies in the History of Chemistry, Vol 5, *review* by Prof J R Partington, 1900
Leighton, Prof Robert B Principles of Modern Physics, *review* by Dr E Stanley, 1438
Leiocephalus cubensis Complex in Cuba and the Isla de Pinos Variation in Lizards of the (Albert Schwartz), 1107
Leisure and Learning in Two Towns After Work— (R Ruddock and Dr A Wilson), 1034
Lenihan, Dr J M A Radioactivation Analysis, 951
Lens of the Rat with 'Sugar' Cataract Formation of Polyols by the (Dr Ruth van Heyningen), 194
Lenses (Zone) Deviation of, produced by Polarization (Prof Jurgen R Meyer-Arendt), 811
Leopoldina Academy of Natural Sciences Halle Election of new Members, 595
Lepidopterous Insects Relationship between Larval and Pupal Periods of some (Dr M A Zaher and Dr Moufied A Moussa), 288
Lepidurus arcticus in the Irish Late-Glacial (Dr M E S Morrison), 739
Leptinotarsa decemlineata (Say) Common Attractant for the Tobacco Hornworm, *Protoparce sexta* (Johan) and the Colorado Potato Beetle (Dr Robert T Yamamoto and Prof G Fraenkel), 206
Leptomeria billardierii R Br Occurrence of Embryo Sac-like Structures in the Microsporangia of (Dr Manasi Ram), 914
Leray, Jean Elected an Honorary Member of the American Academy of Arts and Sciences, 409
Lerman, Dr Sidney Carbohydrate Metabolism in the Experimental Galactose Cataract, 1406
Lerner, Prof Aaron B Mechanism of Hormone Action, 674
Lesion of the Follicle and of the Fibre of Wool and its Possible Relation with an Excess of Iron in the Forage (Prof G Gonzelez, J Garcia and E Fernandez), 559
Lesion Formation in Virus-infected Plant Tissues Biochemical Mechanism of (Dr F Solymosy, Dr G L Farkas and Dr Z Kiraly), 706
Leslie, Dr I Cell and Organ Culture, 935
  The Culture of Cells, *review*, 1009
Leslie, W C, and others X-Ray Diffraction Pattern of Carbide in Low-Carbon Iron-Silicon Alloys, 1862
Leston, Dennis (Southwood Dr T R E, and) Land and Water Bugs of the British Isles, *review* by W J Le Quesne, 1977
L'Estrange, John Awarded a junior post-graduate agricultural research scholarship by An Foras Taluntais (the Agricultural Institute of Ireland), 1612

Lethal and Sub-Lethal Doses of Cottonmouth Moccasin Venom labelled with Iodine-131 Distribution in the Mouse of (Prof J F Gennaro, jun , and H W Ramsey), 1244

Lethally Irradiated Mice Interstrain Ovarian Transplantation in, after Bone Marrow Therapy (Prof W St Amand and L H Smith), 1503

Lethally X-Irradiated Mice Abrogation by Injected Mouse Blood of Protective Effect of Foreign Bone Marrow in (L J Cole and R M Garver), 1815

Lethals (Recombinational), in a Polymorphic Population (J B Gibson and Prof J M Thoday), 1593

Letort, M , and others Coal Science (Energy of Activation of the Combustion of Graphite), 414

Leuco-Anthocyanin in Sour and Sweet Cherries Occurrence of (Dr Kuang C Li), 1935

Leucrose Formation of, in Dextran-producing Cultures of *Streptococcus bovis* (R W Bailey and Prof E J Bourne), 904

Leukaemia (Radiation) Dose–Response Relationship in (Dr P Armitage, Dr W M Court Brown and Dr R Doll), 1669 , (Dr D J Mewissen), 1670

Leukaemia (Spontaneous), in *AKR* Mice Chromosome Complement of (H F Stich, R Wakonig and Dr A A Axelrad), 998

Leukaemia and allied Diseases Research on (Lady Tata Memorial Trust Awards for), 507

Leukaemic Filtrate Fate of Subcutaneous Thymus Grafts in Thymectomized Mice Inoculated with (J F A P Miller), 1809

Level of Microbial Population Effect of the, on Isotopically Exchangeable Phosphate in Soil (Dr P Newbould and Dr R L Lucas), 1155

Level of Plasma Cholesterol in the Rat Effect of Dietary Fat and Extent of Blood Sampling on the (I Coleman and J M R Beveridge), 1039

Level of Serum Protein during Treatment of Kwashiorkor Changes in the (Dr Olumbe Bassir), 2019

Level (High-) β-Amino-isobutyric Acid Excretors in Micronesians High Prevalence of (Dr B S Blumberg and Dr S M Gartler), 1990

Levels (High), of Phosphorus and Die-Back in Yellow Lupins (R G Warren and B Benzian), 1588

Levels (High), of Survival Mutation of Bacteria at, by Ethyl Methane Sulphonate (Anthony Loveless and Sheila Howarth), 1780

Levels (Ubiquinone), in Rat Liver Mitochondria Pantothenic Acid Deficiency and (A S Aiyar, G A Sulebele, D V Rege and A Sreenivasan) 1867

Levengood Dr W C Structural Defects in Fused and Crystalline Silica, 1476

Levenson, Dr Stanley M , and others Chromatographic Fractionation of Rat Tail Tendon Collagen, 1640

Leveque, P Radioactivation Analysis (Applications in Industry), 951

Levi, Elaine, and others Tumour Specificity and Immunological Suppression, 563

Levin, R Appointed development planning executive at Aspro-Nicholas, Ltd , 1192

Levine, Dr Norman D Elected president for 1959-60 of the United States Society of Protozoologists, 1273

Levine, Prof Ruth R Presence of certain Onium Compounds in Brain Tissue following Intravenous Administration to Rats, 1412

Levinstein Memorial Lecture of the Society of Chemical Industry (L H Williams), 1915

Levinthal, C Specificity in Protein Biogenesis (Relationship between Deoxyribonucleic Acid and Protein Structures), 1198

Levvy, Dr G A (Conchie, J , and) Localization of β-Glucuronidase in Normal and Cancer Cells, 1709

Levy, Dr H R Steric Aspects of the Chemistry and Biochemistry of Natural Products (Stereospecificity in the Reactions of Pyridine Nucleotides), 949

Levy, Dr Lester M , and others Enzymes and Radioactivity in Erythrocytes of Different Ages, 643

Lewis, D Cytoplasmic Inheritance (Lysis in the Fungus *Coprinus lagopus*), 1012

Lewis, D (Annison, E F , and) Metabolism in the Rumen, *review* by Dr D P Cuthbertson, 839

Lewis, F J W , and Plaice, Dr Constance H J Urinary β-Glucuronidase Activity in Patients with Bone Fractures, 1249

Lewis, P R , and McCutchen, Dr C W Mechanism of Animal Joints—Experimental Evidence for Weeping Lubrication in Mammalian Joints, 1285

Lewisian Rocks from North-West Scotland Rubidium-Strontium Ages of (Dr Bruno J Giletti), 1793

Leyton, Dr L Effects of Forest Areas on Water Resources, and the Technique of Lysimeters—Water and Woodlands, 1184

L'Heritier, Ph Cytoplasmic Inheritance (Carbon Dioxide Sensitivity in *Drosophila*) 1012

Lhotka, Prof John F Histochemical Use of the Cyanocarbon Organic Compounds, 1153

Lhotka, Prof John F , and others Effect of Prolonged Thyroid Administration on Aged Male Rats, 1149

Li, Dr Kuang C Occurrence of Leuco-Anthocyanin in Sour and Sweet Cherries 1935

Liacopoulos P and others Promoting Effect of Urea on the *in vitro* Passive Sensitization of Isolated Plain Muscles with Precipitating Antibody 1805

Liben, L , et autres Carte des Sols et de la Vegetation du Congo Belge et du Ruanda-Urundi, 6, Yangambi, Planchette 3, Lilanda, A, Sols , B, Vegetation (Institut National pour l'Etude Agronomique du Congo Belge) 27

Liberty in an Age of Science (Sir Solly Zuckerman), 135

Libikova H , and others Infectious Ribonucleic Acid from Mouse Brains infected with Tick-borne Encephalitis Virus, 1581

Libraries University (Home Universities Conference 1959), 1613

Libraries for Industry and Commerce, Tyneside Association of, 25

Libraries (Public, Rate Supported) in Great Britain and Northern Ireland Statistics of, 1957-1958 (Library Association), 592

Library of Sir Joseph Banks Some Eighteenth Century Bird Paintings in the (1743-1820) (Averil Lysaght), 941

Library (National Lending), for Science and Technology Appointment of a Consultative Committee, 1449

Library Association Statistics of Public (Rate Supported) Libraries in Great Britain and Northern Ireland, 1957-1958, 592

  Annual Conference, 1455

  Presidential Address (Earl Attlee), 1455

  Handicapped Children in Britain—their Problems and Education (compiled by W A Axford), 1777

Library Services in Britain Science and the, 1455

Lichtentaeler, Dr At the 139th Annual Meeting of the Swiss Society for Natural Sciences (Mathematical Aspect of the Hippocratic Logos), 1455

Liebster, J , and Andrysek, O Labelling of Rose Bengal with Iodine-131 by Radioactive Exchange, 913

Lied, F , and others The *D* Region of the Ionosphere, 973

Lietz, Prof J Alpine Mineral Fissures (Experiments on Cubes of Colourless Quartz to convert them into Smoky Quartz by Electrolysis), 1910

Life of Frederick Soddy, *review* by Prof Norman Feather, 298

Life of Steel (Aerobic Corrosion Fatigue) Relationship to *p*H to (Dr Frederick J Radd, L Hugh Crowder and Louis H Wolfe), 2008

Life and Times of Sir Charles Hastings, Founder of the British Medical Association (Dr William H McMenemey), *review* by Dr W R Bett, 923

Life (Animal) South African—Results of the Lund University Expedition in 1950-51, Vol 5 (edited by Bertil Hanstrom, Per Brinck and Gustaf Rudebeck), *review*, 133

Life (Native), in Angola, 226

Life-Cycle of *Cyathostoma lari*, Blanchard 1849 (Nematoda, Strongyloidea), (Dr R T Pemberton), 1423

Lifetimes (Kinetic Chain) A Modified Rotating-Sector Method of measuring (Dr W I Bengough, S A McIntosh and R A M Thomson), 266

Lifshitz, E M (Landau, L D , and) Statistical Physics (translated from the Russian by E Peierls and R F Peierls), *review* by Dr H Steeple, 664

Ligament Does an Increase in the Tension in a, elicit Reflex Muscular Responses? (Dr Beril Stener), 1495

Ligament in the Dorsal Aorta of certain Fishes (Dr L L de Kock and Dr S Symmons), 194

Light into Chemical Energy Conversion of, in Photosynthesis (Prof Daniel I Arnon), 10, *errata*, 1613

Light from the Corona Discharge (Dr R W E Cook), 1055

Light from Noctilucent Clouds Polarization of (Georg Witt), 1618

Light-induced Production of Carotenoid Pigments by *Cephalosporia* (R C Codner and B C Platt), 741, *erratum*, 1108

Light (Polarized) Orientation of Animals to (Dr H Kalmus), 228

  Response of a Single Retinula Cell to (M Kuwabara and K Naka), 455

Light (Red) Complex Reaction in *Hyoscyamus niger* upon Night Interruption with (P J A L de Lint), 731

Light (Ultra-Violet) Annealing of Recoil Damage by (F R C Claridge and Dr A G Maddock), 1932

  Macromolecular Synthesis in Bacterial Recovery from (C O Doudney), 189

Light Hydrocarbons Analysis of (G R Primavesi), 2010

Light Pattern Spectroscopy (Subjective), in the Encephalographic Frequency Range (Prof M Knoll and J Kugler), 1823

Light Quantity Fusion Frequency and (A Angel, D A Hems, W Rose, R C Woledge and Dr R A Weale), 1873

Light Regulation of Coat-Shedding in a Tropical Breed of Hair Sheep (R B Symington), 1076

Lighthill, Prof M J Appointed director of the Royal Aircraft Establishment, Farnborough, 151 , work of, 151

Lights (Ultra-Violet) Application of, to Underwater Research (Richard G Woodbridge III, and Dr Richard C Woodbridge), 259

Lights (White and Colored), and Darkness Behavior and Reactions of the Pacific Sardine, *Sardirops caerulea* (Girard), under the Influence of (Dr A S Loukashkin and Dr N Grant), 865

Lill, Gordon, and Bascom, Willard A Bore-Hole to the Earth's Mantle—AMSOC s Mohole, 140

Lima, Fausto W , and Pieroni, Rômulo R Paper Chromatographic Separation of Components of Rose Bengal Labelled with Iodine-131, 1065

Limb Development in the Absence of Ectodermal Ridge (Dr Eugene Bell, Dr John W Saunders, jun , and Dr Edgar Zwilling), 1736

Limber, Dr D Nelson (Anders, Edward, and) Origin of the Worzel Deep-Sea Ash, 44

Limestone (Tufaceous), near Udaipur Pollen of *Acacia* from (T Trivedi), 123

Limitations Imposed by some Water-borne Preservatives on the Soil Block Test Method for Timber (A J McQuire) 1430

Limnaea truncatula Penetration of the Liver-fluke, *Fasciola hepatica*, into the Snail (Dr Ben Dawes), 1334

Lind, Dr A R Heating and Ventilation (Work in Hot Environments), 1987

Lind, Patricia E , and others Failure to Recover Infective 'Ribonucleic Acid' from Myxovirus Preparations, 360

Lindahl, Prof Per Eric, and Wedin, Kjell Registration of the Spermicidal Effects of Dioctyl Sodium Sulphosuccinate, 1289

Lindegren, Prof Carl C Cancer and the Respiratory Grana, 397

Linderstrøm-Lang, Prof Kaj U *Obituary* by Dr C B Anfinsen, jun , 314

Lindley, H Structure and Chemistry of Proteins (Varying Reactivity of the Disulphide Bonds of Insulin), 1277

Lindner, E B , and others Gel Filtration as a Method for Purification of Protein-bound Peptides exemplified by Oxytocin and Vasopressin, 1565

Lindner, H R Blood Cortisol in the Sheep—Normal Concentration and Changes in Ketosis of Pregnancy, 1645

Lindop Dr Patricia J , and others Statement on Biological and Chemical Warfare 1018

Lindop T W Special Ceramics (Measuring Thermal Conductivity), 1116

Linear Accelerator (Proton), at the Rutherford High Energy Laboratory 94

Linear Communication Networks Synthesis of (Wilhelm Cauer), second edition edited by Wilhelm Klein and Franz M Pelz (translated from the German by G E Knausenberger), *review*, 1525

Linear Operations and Classical Analysis, *review* by Prof L S Goddard, 1763

Linear Operators (Nelson Dunford and Jacob T Schwartz), Part I, General Theory, *review* by Prof L S Goddard, 1763

Linear Relation between Two Observed Quantities A Least-Squares Solution for a (P A Wayman), 77 , (B K Kelly) 1086

Linear Structural Analysis (Prof P B Morice), *review* by R K Livesley, 1600

Linear and Non-Linear Structural Relations Estimation of (D E Barton and C L Mallows), 1086

Linnean Society of London   Election of Officers for 1959-60, B A 16
Symposium on Comparative Studies in Ultra-structure, 1445
Symposium on Quaternary Ecology, 1535
Linnet   An Unusual Breeding Habitat of the (N W Orford), 650
Linnewiel, H A (de Jongh, Dr D K, and)   A Peripheral Effect of the Bromide Ion on the Contraction of Striated Muscle, 1240
Linschitz, H, and Eloranta, J   Fast Chemical Reactions in Solution (Flash Photolysis to Study Metal and Hydrocarbon Ion Solutions), 1453
Linsley, Prof Ray K   Techniques for Surveying Surface-Water Resources (World Meteorological Organization, Technical Note No 26), 96, *erratum*, 684
Linstead, Sir Hugh   Appointed a member of the Medical Research Council, B A 16
Appointed House of Commons member of the Medical Research Council, 772
Liogier, A   Origin and Dispersal of Flowering Plants (Cuba drew most of its Species from Sub-tropical and Temperate North America), 1201
Lipase Activity in the Brown and Yellow Adipose Tissue of the Bat (Prof J C George and J Eapen), 59
Lipetz, Dr Jacques   A Possible Rôle of Indoleacetic Acid Oxidase in Crown Gall Tumour Induction, 1076
Lipid Emulsions   Lymphoid Necrosis Induced by (Dr A A Shivas and Dr G P Fraser), 1813
Lipide Peroxidation in Tissues Deficient in Vitamin E   An Effect of Selenium and Cystine on (Dr John G Bieri), 1148
Lipids   Hydrogenation of, by Rumen Protozoa (Dr D E Wright), 875
Lipids from Silicic Acid   A Concave Concentration Gradient of Ethanol in Chloroform employed in Elution of (J J Wren), 816
Lipids (Rat Adrenal)   Use of Porter–Silber and Schiff Reactions as Spot Tests for Steroids applied on Paper and their Application to the Study of (Dr Marion K Birmingham), B A 67
Lipoperoxidase Factor in Soya Extracts (Dr John A Blain and Edward C C Styles), 1141
Lipoxidase   Radiomimetic Action of (P Puig Muset J Martin Esteve and J Valls Mateu), 1506
Lippincott, Dr James A, and others   Replication of Tobacco Mosaic Virus—Kinetics of Virus Protein and Ribonucleic Acid Biosynthesis, 1992
Lipscomb, Prof William N, and others   Structure of Cellobiose, 1719
Lipson, Prof H   X-Ray Powder Methods, *review*, 1599
Lipson, Prof H, and Lipson, S G   Guide to Modern Physics, *review*, 298
Lipson, S G (Lipson, Prof H, and)   Guide to Modern Physics, *review*, 298
Lipton, A   Physiological Activity in Extracts of *Albizia* Species, 822
Liquation Differentiation in Magma (V I Lebedinsky), 1025
Liquid Crystal Systems from Fibr llar Polysaccharides (R H Marchessault, F F Morehead and N M Walter), 632
Liquid *n*-Hexane   Conduction Currents in, under Microsecond Pulse Conditions (A Harry Sharbaugh and P Keith Watson), 2006
Liquid Mixtures   Liquids and (Dr J S Rowlinson), *review* by Prof H C Longuet-Higgins, 1901
Liquid Partition Chromatography   Volatile (Dr Roger S Porter and Dr Julian F Johnson), 978
Liquids   Propagation of Ultrasonic Waves in (Prof A K Dutta, M Subudhi and K Samal), 352
Properties of, *review* by Prof H C Longuet-Higgins, 1901
Liquids (Metallic)   A Structural Model for Monatomic Liquids including (Dr Kazuo Furukawa), 1209
Liquids (Mobile)   Proton Resonance Relaxation Times in (Dr J G Powles and D Cutler), 1123
Liquids (Monatomic), including Metallic Liquids   A Structural Model for (Dr Kazuo Furukawa), 1209
Liquids and Liquid Mixtures (Dr J S Rowlinson), *review* by Prof H C Longuet-Higgins, 1901
Liquids and Solids   Molecular and Atomic Motions in, by Radiofrequency Methods (Colloque AMPERE and the Radiofrequency Spectroscopy Group Joint Discussion on), 157
Liquori, Prof A M, and others   Influence of Counterion Association on the Configurational Stability of Deoxyribonucleic Acid in Solution, 1482
Lister Institute of Preventive Medicine   Report of the Governing Body for 1959, 332
Literature   Science and, *review* by Dr W L Summer, 5
Lithium Permanganate   Szilard-Chalmers Reaction in (J R Bolton and Prof K J McCallum), 1717
Litières de la Région de Yangambi   Moississures du Sol et des (J Meyer), 236
Littauer, Dr U Z (Cox, Dr R A, and)   Secondary Structure of Ribonucleic Acid in Solution, 818
Litter Extracts (Forest-Tree)   Factors in, affecting the Growth of Soil Micro-Organisms (Dr Roger Knowles and Edward Laishley), 1169
Litters   Antibody Status of Mice and Response of their, to Parotid Tumour Virus (Polyoma Virus), (Lloyd W Law, Clyde J Dawe, Wallace P Rowe and Janet W Hartley), 1420
Little, Inc, Arthur D   Report on Radiation in Industry, 506
Little, Brian T   Awarded a junior post-graduate agricultural research scholarship by An Foras Taluntais (the Agricultural Institute of Ireland), 1612
Little, E C S   A Method for Determining Carbon-14 by Combustion using Calcium Carbonate, 900
Little Research Institute, Arthur D   First Annual Report, 235
Littlechild, Dr J E   Nuclear Fuel Treatment, *review*, 1346
Littler, Dr S, and Waters, Dr W A   Oxidation of Organic Compounds (Pentavalent Vanadium becomes an Oxidiser in Acid Solution), 327
Littler, Dr W B   Rocket Propulsion, 1264
Littlewood, A B   Sensitivity of Catharometers in Gas Chromatography and the Thermal Conductivity of Binary Gas Mixtures, 1631
Littlewood, K   Appointed lecturer in fuel technology and chemical engineering at the University of Sheffield, 684
Litton, E   Appointed lecturer in civil engineering at the University of Sheffield, 1451
Liver   Synthesis of Diphosphopyridine Nucleotide from Nicotinamide by Slices of (C J Threlfall), 60
Liver (Bovine)   Chromium Ribonucleoprotein from (Dr W E C Wacker and Dr B L Vallee), 1399
Liver (Foetal)   Relative Rates of Exchange of Potassium-42 by the Foetal Metanephros and (Dr J G Bearn and Dr F T C Harris), 1959
Liver (Guinea Pig)   Agar Electrophoresis of Normal Soluble Proteins in (Prof Iv Goranov, Y Todorov, X Skatshokova, M Hlebarova and P Kuzmanova), B A 64
Cytoplasmic Nucleopeptides in (P Szafranski, E Sulkowski and T Golaszewski), 1940
Liver Cells (Parenchymatous)   Some Enzymatic Properties of Suspensions of (Dr Keith S Henley, Ole Sorensen and H Marvin Pollard), 1400
Liver Function in the Sheep   Effects of Carbon Tetrachloride on Kidney and (Dr B P Setchell), 1242
Liver Glucosyl Oligosaccharides and Glycogen—Carbon-14 Dioxide Experiments with Hydrocortisone (Dr Hsien-Gieh Sie, Prof James Ashmore, Dr Robert Mahler and Prof William H Fishman), 1380
Liver Glycogen Level of Normal and Adrenalectomized Mice   Effect of Diet on the Blood Sugar and (B P Block and Dr G S Cox), 721
Liver Hexokinase   Inhibition of, by Dehydroascorbic Acid and Alloxan (Dr S K Bhattacharya), 1638
Liver Mitochondria   Functional Organization of the Respiratory Chain in (Dr Tokuji Kimura and Dr Thomas P Singer), 791
Liver Mitochondria (Isolated Rat)   Protein Biosynthesis and Oxidative Phosphorylation in (P J Reis, J L Coote and T S Work), 165
Liver Mitochondria (Rat)   A Cardiolipin-like Compound in (G S Getz and W Bartley), 1229
Formation of Noradrenaline from Adrenaline by (Dr Kunio Yagi and Dr Toshiharu Nagatsu), 1316
Pantothenic Acid Deficiency and Ubiquinone Levels in (A S Aiyar, G A Sulebele, D V Rege and A Sreenivasan), 1867
Liver Oils (Fish)   Isomers of Vitamin A in (Patricia S Brown, William P Blum and Max H Stern), 1377
Liver and Kidney Cells   Absorbancy Measurements on (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Dr Bo Thorell and Prof Britton Chance), 934
Liver, Kidney and Adjacent Tissues   Tumourigenesis in Ovaries of Mice transplated to the (Dr Mary J Guthrie), 916
Liver-fluke, *Fasciola hepatica*   Penetration of the, into the Snail *Limnaea truncatula* (Dr Ben Dawes), 1334
Liverpool Geological Society   Centenary of the, 1914
Liverpool Public Museums   Exhibition of Working Models of Marine Engines, 1534
Lives (Working), of Men   Age and the (F Le Gros Clark), 318
Livesley, R K   Matrix Algebra in Structural Analysis, *review*, 1600
Livestock Farming (Lancashire), in the Great Depression (T W Fletcher), 1916
Living Cell   Inside the (Dr J A V Butler), *review* by Dr W L Sumner, 134
Living Cells (Single)   Localization and Assay of Respiratory Enzymes in—Absorbancy Measurements on the *Nebenkern* (Dr Robert P Perry Dr Bo Thorell, Dr Lennart Åkerman and Prof Britton Chance), 929 , Fluorescence Measurements of Mitochondrial Pyridine Nucleotide in Aerobiosis and Anaerobiosis (Prof Britton Chance and Dr Bo Thorell), 931 , Absorbancy Measurements on Liver and Kidney Cells (Dr Bo Thorell and Prof Britton Chance), 934
Living Resources of the Sea (Dr Lionel A Walford), *review* by Dr F S Russell, 129
Living Species   The Evolution of (Royal Society of Victoria Symposium on), 156
Living Systems   Self-Regulation in (Second Ottawa Symposium on), 239
Livingston, Prof R   Energy Transfer with special reference to Biological Systems (Properties of Isolated Chlorophyll), 690
Lizard *Trachysaurus rugosus* (Gray)   Effects of Elevated Plasma Sodium Concentration on Sodium and Potassium in the Erythrocyte of the (P J Bentley), 1403
Lizards of the *Leiocephalus cubensis* Complex in Cuba and the Isla de Pinos Variation in (Albert Schwartz), 1107
Ljunggren, H, and Fahraeus, G   Effect of *Rhizobium* Polysaccharide on the Formation of Polygalacturonase in Lucerne and Clover, 1578
Ljunggren, Prof Pontus   Biogeochemical Enrichment of Fission Products, 912
Lloyd, Dr A G, and Dodgson, K S   Infra-Red Spectra of Carbohydrate Sulphate Esters, 548
Lloyd, D G, and others   Cross-linking of Cellulose Acetate by Ionizing Radiation, 1303
Lloyd, Dr David P C   Response of Cholinergically Innervated Sweat Glands to Adrenaline and Noradrenaline, 277
The Discrete and the Diffuse in Nervous Action (James Arthur Lecture on the Evolution of the Human Brain), 1777
Lloyd-Jacob, Marny A (Scott, Dr Patricia P, and)   Reduction in the Anoestrus Period of Laboratory Cats by Increased Illumination, 2022
Lo, Arthur W, and others   Transistor Electronics, *review* by J W R Griffiths, 838
'*LO*-Analysis' as an Aid in the Study of Fungal Spore Morphology (Dr M M Payak), 738
Lobban, Dr Mary C   Animal Clocks, 765
Local Races in Lugworms, *Arenicola marina* (L), (Dr A Duncan), 71
Localization of β-Glucuronidase in Normal and Cancer Cells (J Conchie and Dr G A Levvy), 1709
Localization of Haemocyanin on Starch Gel Electrophoretic Patterns (J R Whittaker), 193
Localization (Histochemical), of Oxidase Activity in the Mitochondria of the Human Heart (Dr M S Burstone), 476
Localization (Histological), of Fluorescent Thyroid-stimulating Hormone in Rat Tissues (Dr E E Mancini, O Vilar, J M Dellacha, A Gimeno and A Castro), 1733
Localization (Histological), of Peroxidase (D S Van Fleet), 506
Localization and Assay of Respiratory Enzymes in Single Living Cells—Absorbancy Measurements on the *Nebenkern* (Dr Robert P Perry, Dr Bo Thorell, Dr Lennart Åkerman and Prof Britton Chance), 929 , Fluorescence Measurements of Mitochondrial Pyridine Nucleotide in Aerobiosis and Anaerobiosis (Prof Britton Chance and Dr Bo Thorell), 931 , Absorbancy Measurements on Liver and Kidney Cells (Dr Bo Thorell and Prof Britton Chance), 934
Localized Distension of the Oesophagus in Decerebrate Sheep   Responses to (Prof A F Sellers and Dr D A Titchen), 645
Location (Echo-) among *Collocalia* (Lord Medway), 1352
Lochte-Holtgreven, W   Ionization Phenomena in Gases (Results of Mass Spectrographic Analyses of Heavy Ions in Electro-magnetically Compressed Arcs), 1355

Lockard, Dr R G , and others Swellings on the Shoots of Cacao Plants Deficient in Copper, 75
Locke, Dr M Secretion of Wax through the Cuticle of Insects, 1967
Locke Research Fellowship of the Royal Society awarded to Dr B G Cragg, 595
Locke Research Fellowship of the Royal Society awarded to Dr Ainsley Iggo, 772
Lockwood, Dr A P M , and Croghan, Dr P C Composition of the Haemolymph of *Petrobius maritimus* Leach, 370
r-Locus of *Drosophila melanogaster* Complementation among the Sub-Genic Mutants in the (Dr O G Fahmy and Dr Myrtle J Fahmy), 1927
Locus (Vby), in *Trifolium repens* Separation by Gamma-Irradiation of Two Elements at the (Dr D Roy Davies and E T Wall), 1957
Locust, *Schistocerca gregaria* Effect of Insecticides on the Bodies of Nissl and Neurofibrillae of the (Dr Tohamy A Moussa and M Banhawy), 915
Locust (Migratory) Maternal Control of Ovariole Number in the Progeny of the (F O Albrecht, M Verdier and R E Blackith), 103
Locust Outbreaks Forecasting (Dr D L Gunn and P M Symmons), 1425
Locust (Red) Control Service, International Work of the, 589
  Retirement of Dr D L Gunn from the directorship, 589
  Appointment of C du Plessis as director, 590
Lodge, Dr A S Flow Properties of Biological Systems, 1539
Loeb, John N , and others Photochemical and Stereochemical Properties of Carotenoids at Low Temperatures—*Cis-trans* Isomerism and Steric Hindrance, 617
Loeff, Israel, and Stein, Gabriel Aromatic Ring Opening in the Presence of Oxygen in Irradiated Solutions, 901
Loewenberg, J R , and others A Virus Disease of *Meloidogyne incognita incognita*, the Southern Root Knot Nematode, 1896
Lofts, B , and others Duration of the Regeneration Period of the Internal Reproductive Rhythm in a Xerophilous Equatorial Bird, *Quelea quelea*, 1659
Logan, A Oil Pollution of the Sea (Methods of Cleaning Cargo Tanks) 950
Logan, Dr W P D , and Cushion, A A Morbidity Statistics from General Practice, Vol 1, General (Studies on Medical and Population Subjects, No 14), 154
Logemann, Dr W , and others Sulphonamides with Diuretic Activity, 1711
Lomax, G D (Rollinson, D H L , and) Paper Electrophoresis of Hippopotamus Haemoglobin, 1653
Lomer, W M Solid State Physics, 1117
London, Dr Heinz Awarded the first Simon Memorial Prize of the Low Temperature Group of the Physical Society, 1026
London Mathematical Society Annual General Meeting, 1533
  De Morgan Medal presented to Sir William Hodge, 1533
  Presidential Address, Some Recent Progress in the Analytic Theory of Numbers (Prof H Davenport), 1533
London School of Economics and Political Science Title of reader in sociology in the University of London conferred on T B Bottomore, 508
  Appointment of Dr G Morton to the University of London readership in operational research, 1451
London School of Hygiene and Tropical Medicine Title of professor of virology in the University of London conferred on Dr Forrest Fulton, 1108
  Title of professor of epidemiology in the University of London conferred on Dr D D Reid, 1108
London and Home Counties Regional Advisory Council for Technological Education Tenth Annual Report, 94
Long, Cornelius Awarded a junior post-graduate agricultural research scholarship by An Foras Taluntais (the Agricultural Institute of Ireland), 1612
Long, Leon E , and others The Geological Time-Scale, B A 62
Long, L H Thermodynamics (Experimental Thermochemistry), 1608
Long-chain Fatty Acid Methyl Esters Gas Chromatographic Separation of, on Polyvinyl Acetate (Irwin Hornstein, L E Elliott and P F Crowe), 1710
Long Island Biological Association Grant of 135 000 dollars from the United States National Science Foundation, 683
Long Platelets from Pulmonary Megakaryocytes A Possible Explanation of the Formation of (Dr J George Sharnoff), B A 75
Long-Running Thermal Precipitator Measurement of Asbestos Dust Concentrations with the (Dr C G Addingley and Dr R Gaze), 715
Long Shoots of *Ginkgo biloba* Vein Anastomoses in the Leaves of (Dr Howard J Arnott), 1336
Longfield, M D Appointed to a lectureship in the Department of Mechanical Engineering in the University of Leeds, 1108
Longhurst, Alan R Prediction of Selection Factors in a Tropical Trawl Fishery 1170
Longman, Dr K A , and Wareing, Prof P F Early Induction of Flowering in Birch Seedlings, 2037
Longmore, J (Hopkinson, Dr R G , and) Awarded the Leon Gaster Memorial Premium for 1959 of the Illuminating Engineering Society, 1272
Longmuir, Dr I S , and Bourke, Dr Ann Application of Warburg's Equation to Tissue Slices, 634
Longuet-Higgins, Prof H C Energy Transfer with special reference to Biological Systems, 689
  Scientific Research and the Philosophy of Science, 1193
  Properties of Liquids, *review*, 1901
Longuet-Higgins, Dr M S Fluctuation Phenomena and Stochastic Processes (Sea-Waves as a Stochastic Process), 512
Lonsdale Dame Kathleen Intermolecular Distances and Diamagnetic Anisotropy in Crystals as Measures of the Polarity of Benzene and Borazole Substituents, 1060
Lonsdale, Dame Kathleen, and Milledge, Dr H Judith An X-Ray Study of Rigid-Body and Internal Vibrations of Organic Molecules, 1545
Looking for Animals in East Africa (E H Tong), 1535
Looms, J S T Ionization Phenomena in Gases (Importance of Corona as a Source of Interference with Micro-wave Communication), 1355
Loosli, J K , and others Effect of 'Amino-Acid Imbalance' on Growth and Vitamin A Storage in the White Rat, 1404
Lord Privy Seal The Office of the, 1190
Losche, A Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Loss of Data Loss of Information brought about by (S C Pearce), 1826
Loss of Information brought about by Loss of Data (S C Pearce), 1826
Loss of Plasticity of Erythrocytes coated with Incomplete Antibodies (Prof C T Nicolau, P Teitel and M Fotino), 1808
Loss of Wool in Sheep caused by 1-*p*-Aminophenoxy-5-phthalimidopentane (Dr D L Hughes), 1644
Loukashkin, Dr A S , and Grant, Dr N Behavior and Reactions of the Pacific Sardine, *Sardinops caerulea* (Girard), under the Influence of White and Colored Lights and Darkness, 865
Loutit, J F , and others (edited by) Medical Sciences, Vol 2 (Progress in Nuclear Energy, Series 7), *review* by Dr N M Blackett, 1766
  Biological Sciences, Vol 2 (Progress in Nuclear Energy, Series 6), *review* by Prof G Pontecorvo, 1902
Loutit, J S Effect of Ultra-Violet Irradiation on Transduction in *Pseudomonas aeruginosa*, 1960
Love The Origins of, 1203
Loveday, Robert A First Course in Statistics, *review* by J Durbin, 1008
Loveless, Anthony, and Howarth, Sheila Mutation of Bacteria at High Levels of Survival by Ethyl Methane Sulphonate, 1780
Lovell, Prof A C B (Davies, Dr J G , and) Observations of the Russian Moon Rocket *Lunik II*, 501
Low, J R Atomic Mechanisms of Fracture (Fractographic Studies), 325
Low, Kerstin, and others Fractionation Phenomena in Nuclear Weapons Debris, 1771
Low-Carbon Iron-Silicon Alloys X-Ray Diffraction Pattern of Carbide in (G Konoval, L Zwell, L A Gorman and W C Leslie), 1862
Low Concentration of certain Blood Constituents observed in Offspring of Alloxan-Diabetic Rabbits (Dr Otakar Sirek and Dr Anna Sirek), 456
Low Doses of Ionizing Radiations Biological Effects of (Unesco, the International Atomic Energy Agency and the Comitato Nazionale per le Ricerche Nucleari Symposium on), 1111
Low-Energy Particle Tracks Bubble Counting on (I R Birss), 1474
Low Frequencies Measurement of Cosmic Noise at, above the Ionosphere (J P I Tyas, C A Franklin and A R Molozzi), 785
Low-Frequency (100 kc /s) Radio Noise from the Aurora (R L Dowden), 803
Low Frequency (Very) Phenomena at Godhavn, Greenland Observations of 'Whistlers' and (Eigil Ungstrup), 806
Low-Frequency (Very) Spectra of Atmospherics propagated through the Ionosphere (Tatsuzo Obayashi), 34
Low-level Effects (Immediate and), of Ionizing Radiations (Dr Tikvah Alper), 1111
Low Soil Fertility Adaptation of a Lead-tolerant Population of *Agrostis tenuis* to (D Jowett), 43
Low Temperature in Rice Plants Quantitative Changes in γ-Aminobutyric Acid induced by (F Zsoldos), 280
Low Temperature (Extremely) Prefreezing as a Method enabling Animals to survive Freezing at an (Eizo Asahina), 1003
Low-Temperature Autoradiography for the Detection of Tritium in Tissue, with Removal of Luminescence induced by Tritium (P Pellerin, P Fallot, M Laine-Boszormenyi and F Serrel), 1385
Low-Temperature Chars Smoke Emission from Coal and (Studies of Coal), (D Finch), 426
Low-Temperature Engineering, *review* by Dr G G Haselden, 1174
Low-Temperature Physics Experimental Techniques in (Guy Kendall White), *review* by Prof J F Allen, 1260
Low- and High-Temperature Strains of *Chlorella* Tabular Comparative Data for the (Dr Constantine Sorokin), 613
Low Temperatures Photochemical and Stereochemical Properties of Carotenoids at (Staff of the Biological Laboratories of Harvard University)—Photochemical Behaviour of Retinene (Dr Lawrence Jurkowitz), 614, *Cis-trans* Isomerism and Steric Hindrance (John N Loeb, Paul K Brown and Prof George Wald), 617 , Discussion (Prof George Wald), 620
Low-Voltage Arcs Emission of Relatively High-Energy Ions from (E R Harrison), 245
Low Water Content (High and) Free Radicals in X-Rayed Seeds of, as Measured by Electron Spin Resonance (Dr W Klingmuller, Dr G R Lane, M C Saxena and Dr D J E Ingram), 464
Lowenstein, Prof O , and Wersäll, J A Functional Interpretation of the Electron-Microscopic Structure of the Sensory Hairs in the Cristae of the Elasmobranch *Raja clavata* in Terms of Directional Sensitivity, 1807
Lowered Bactericidal Efficiency of Hydrogen Peroxide on Milk from Cows treated with Penicillin (J Babad, D L Boros and F Baier), 292
Lowman, Doreen, and others Radioprotective Action of Methoxamine, 1729
Lowther, J S (Arnold, C A , and) Origin and Dispersal of Flowering Plants (Low Representation of Angiosperms in two American Cretaceous Floras), 1201
Lowy, Dr J Comparative Studies of Ultrastructure in Biology, 1445
Lowy, Dr J (Hanson, Dr Jean, and) Evidence for a Sliding Filament Contractile Mechanism in Tonic Smooth Muscles of Lamellibranch Molluscs, 286
Lowy, Dr J , and others Comparative Studies in Ultrastructure (Comparative Studies in the Contractile Structures of Striated and Smooth Muscles), 1446
Loxton, F R , and others Soil and Land-Use Surveys of the Regional Research Centre of the British Caribbean, No 2, The Rupununi Savannas of British Guiana, 27
Lubrication (Weeping), in Mammalian Joints Experimental Evidence for (Mechanism of Animal Joints), (P R Lewis and Dr C W McCutchen), 1285
'Lucalox'—Transparent Sintered Alumina (General Electric Company of America), 1107
Lucas, J W Radiation Safety and Health Physics, 329
Lucas, Dr R L (Newbould, Dr P , and) Effect of the Level of Microbial Population on Isotopically Exchangeable Phosphate in Soil, 1155
Lucas, Ltd , Joseph To finance a Fellowship in the field of metal joining in the Department of Industrial Metallurgy in the University of Birmingham, 1688

Luce, J S Ionization Phenomena in Gases (Trapping of High-Energy Ions within the Walls of a Hollow Vacuum Arc), 1356

Lucerne and Clover Effect of *Rhizobium* Polysaccharide on the Formation of Polygalacturonase in (H Ljunggren and G Fahraeus), 1578

Luciani, S, and others Phospholipid Phosphoric Esters in the Human Placenta, 1870

Ludlovian Succession at Ludlow A Revised Classification of the (C H Holland, J D Lawson and V G Walmsley), 1037

Ludlow A Revised Classification of the Ludlovian Succession at (C H Holland, J D Lawson and V G Walmsley), 1037

Ludovici, B (Kino, G S, and) Ionization Phenomena in Gases (Theoretical and Experimental Studies in Plasma Physics), 1357

Luft, Dr R, and others Enzymic Activities of Human Skeletal Muscle Mitochondria—a Tool in Clinical Metabolic Research, 1851

Lugeon, Prof J, and collaborators At the 139th Annual Meeting of the Swiss Society for Natural Sciences (Les Recoupements Radiogoniographiques des Grands Foyers Orageux de l'Hémisphere Nord depuis la Base Spitzberg-Suisse), 1455, (Comparaison des Regimes des Parasites Atmospheriques Polaires et Européens), 1455 , (Report on Measurements of Atmospheric Electricity and Radioactivity of the Air at Murchison Bay during the International Geophysical Year), 1455

Lugworms, *Arenicola marina* (L) Local Races in (Dr A Duncan), 71

Lumby, J R Polar Front Survey (Hydrography—North Atlantic Ocean), 1183

Luminescence of the Euphausiid *Thysanoessa raschii* Spectral Composition of the (Dr Brian P Boden and Dr Elizabeth M Kampa), 1321

Luminescence induced by Tritium Low-Temperature Autoradiography for the Detection of Tritium in Tissue, with Removal of (P Pellerin, P Fallot, M Laine-Boszormenyi and F Serrel), 1385

Luminous Spots on Electrodes in Insulating Oil Gaps (T W Dakin and Daniel Berg), 120

Lumry, Prof R Energy Transfer with special reference to Biological Systems (Simultaneous Measurements of Hill Reaction Velocity and Fluorescence Yield), 690

Lunar Ephemeris and the Frequency of Caesium in Terms of U T $+ \Delta T$ An Error in the Determination of ΔT from the (C A Murray), 441

Lund, Dr J W G Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 859, 1273 , work of, 859
  Buoyancy in relation to the Ecology of the Freshwater Phytoplankton, 1534

Lunda Flagrantes da Vida na (Introducao de Dr José Osorio de Oliveira), (Companhia de Diamantes de Angola, Museu fo Dundo, Publicacoes Culturais No 37), 236

Lung of the Guinea Pig and other Tissues Mast Cell Population of (Dr W G Smith), 1154

Lung Succinooxidase Effect of Cell-Free Extracts of *Mycobacterium tuberculosis* $H_{37}Rv$ on (Dr A Bekierkunst and M Artman) 458

Lungs A New Method for Studying the Functioning of the (Helge Colldahl, T Alväger and J Uhler), 372

Lunik II Observations of the Russian Moon Rocket (Dr J G Davies and Prof A C B Lovell), 501 , (Patrick Moore), 502 , (Dr H Percy Wilkins), 502

Lunt, E, and others Congeners of Pempidine with High Ganglion-blocking Activity, 1707

Lupins (Yellow) High Levels of Phosphorus and Die-Back in (R G Warren and B Benzian), 1588

Lupton, F G H Biological Problems arising from the Control of Pests and Diseases, 1101

Lupton, T Personnel Management and Technological Change (Studies of the Behaviour of Workers), 1614

Luscher, Dr E F (Bettex-Galland, M, and) Extraction of an Actomyosin-like Protein from Human Thrombocytes, 276

Luszczynski K Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158

Lutsch, Dr A Ultrasonic Barium Titanate Adhesion and Paste Transducers, 1458

Lüttgau, Dr Hans-Christoph Action Potentials from Single Nodes of Ranvier in Potassium-rich Solutions, 1494

Lutwak-Mann, Dr C, and others Carbonic Anhydrase in the Deciduoma of the Rat, 961

Lwoff, Dr Andre, and others Statement on Biological and Chemical Warfare, 1018

Lycopersicum Interspecific Hybrids of (Helgi Nirk), 1819

Lyman-Alpha Photographs of the Sun (J D Purcell, Dr D M Packer and Dr R Tousey), 8

Lymphocytic Cells through Cellulose Membrane Filters Relation of Invasive Capacity to Passage of (Dr Emma Shelton and Dr Mary E Rice), 479

Lymphoid Necrosis Induced by Lipid Emulsions (Dr A A Shivas and Dr G P Fraser), 1813

Lymphoid Tissues (Adult) Influence of, on Polyoma-induced Tumours (Dr V Defendi and Dr H Koprowski), 1579

Lymphomatous Mouse Tissue Partial Identification of Lysins and Agglutinins in (Dr Eric Ponder and Ruth V Ponder), 819

Lyne, A G (Downes, A M, and) Measurement of the Rate of Growth of Wool using Cystine labelled with Sulphur-35 1884

Lyons, Dr L E At the Second Australian Spectroscopy Conference (Solid State Spectroscopy—Effects observed in Ionic Solids and Semi-conductors), 1195

Lyons, Dr L E (Friend Dr J A, and) At the Second Australian Spectroscopy Conference (Two Transitions in the Crystal Spectrum of Sodium Nitrate), 1196

Lyons, Dr L E, and Morris, G C At the Second Australian Spectroscopy Conference (Spectra of Aromatic Hydrocarbons—Absorption of Anthracene Vapour), 1195

Lyons, Dr L E, and others At the Second Australian Spectroscopy Conference (Polarized Visible Spectrum of Single Crystals of Phthalocyanine), 1196

Lysaght, Averil Some Eighteenth Century Bird Paintings in the Library of Sir Joseph Banks (1743-1820), 941

Lysimeters (International Association of Scientific Hydrology, Publication No 49) 1184

Lysimetry Effects of Forest Areas on Water Resources, and the Technique of—Water and Woodlands (Dr L Leyton), 1184 , Lysimeters (F W Green), 1186

Lysins and Agglutinins in Lymphomatous Mouse Tissue Partial Identification of (Dr Eric Ponder and Ruth V Ponder), 819

Lysogenic *Escherichia coli K-12* Induction of Phage Formation in the, by Mitomycin C (Dr Nozomu Otsuji, Dr Mutsuo Sekiguchi, Dr Teiji Iijima and Dr Yasuyuki Takagi), 1079

Lysogeny in the Genus *Proteus* (Prof J N Coetzee and T G Sacks), 1340

Lysozyme Affinity of, to Structural Elements of the Bacterial Cell as studied with Enzyme labelled with Radioactive Iodine (Prof C Weibull, B Zacharias and H Beckman), 1744
  Appearance of Granules in the Cytoplasm of Tumour-Cell Cultures in Contact with (Dr Carlo Callerio), 202, *erratum*, 508

Lyttleton, J W Structure and Chemistry of Proteins (Isolation of Nucleoproteins and Labile Plant Viruses from Leaves), 1277

Lyttleton, Dr R A (Bondi, Prof H, and) A Comparison of Charges on the Electron, Proton and Neutron, 974

MAASS, Dr Alfred R, and Nimmo, Mary Jane A New Inhibitor of Serotonin Metabolism, 547

McAleese, Dr D M, and Forbes, Dr R M Experimental Production of Magnesium Deficiency in Lambs on a Diet containing Roughage, 2025

McArthur, Lloyd Glenn, and others Effect of Prolonged Thyroid Administration on Aged Male Rats, 1149

MacArthur, M (Sampson, D R, and) Floral Abnormalities in Broccoli, 682

McCallum, G H, and others Crystal Structure of L-Serine Phosphate, 1863

McCallum Prof K J (Bolton, J R, and) Szilard-Chalmers Reaction in Lithium Permanganate, 1717

McCarthy, Eileen M (compiled by) List of Smithsonian Publications available on June 30, 1958 (Smithsonian Institution), 95

McCarthy Jean M, and others Maintenance of Parathyroid Tissue Fragments on Agar Substrates, 1734

MacCartney, J T (Ergun, S, and) Coal Science (Spectroscopy of Coals—Light Spectroscopy), 413

McChesney, M, and others Ionization Phenomena in Gases (Behaviour of Argon Arcs in Axial Magnetic Fields), 1355

McCollum, Prof Elmer Verner A History of Nutrition (edited by H Bentley Glass), *review* by Dr Leslie J Harris, 484

McComb, A J Awarded an Overseas Scholarship by the Royal Commission for the Exhibition of 1851, 409

McCombie, Dr C W Fluctuations in Photon Streams, 969

McCracken, Dr D J A Religion of Man?, *review*, 1571

McCrea, Prof J F, and O'Loughlin, Jean Effect of Concentrated Urea Solutions on the Infectivity and Haemagglutinin of Vaccinia Virus, 1497

McCulloch, Marian (Nayler, Winifred G, and) Positive Inotropic Activity of Cytidine Triphosphate, 67

McCulloch, N G Presidential Address to the Fortieth Annual General Meeting of the British Cotton Industry Research Association, 1846

McCullough, J P Thermodynamics (Phase Changes in Condensed Systems), 1608

McCutchen, Dr C W Mechanism of Animal Joints—Sponge-hydrostatic and Weeping Bearings, 1284

McCutchen, Dr C W (Lewis, P R, and) Mechanism of Animal Joints—Experimental Evidence for Weeping Lubrication in Mammalian Joints, 1285

McDermott, E E, and Pace, Dr J Extraction of the Total Protein from Wheaten Flour in the Form of Soluble Derivatives 546

Macdonald, Dr A M G Analytical Chemistry, *review*, 1677

McDonald, Dr D A Flow Properties of Biological Systems (Hydrodynamics of Pulsatile Flow of Blood), 1540

Macdonald, D C, and others Excretion of Labelled Magnesium by the Sheep, 736

Macdonald, D C (Conchie, J, and) Glycosidases in the Mammalian Alimentary Tract, 1233

MacDonald, Dr D K C Fluctuation Phenomena and Stochastic Processes (The Brownian Movement of Non-Linear Systems), 511

MacDonald, Dr D K C, and Martin, Douglas L Self-regulation in Living Systems, 239

McDonald, Dr I W Appointed chief of the Division of Animal Physiology of the Commonwealth Scientific and Industrial Research Organization, 1532 , work of, 1532

McDonald, M F (Raeside, Prof J I, and) Seasonal Changes in the Œstrous Response by the Ovariectomized Ewe to Progesterone and Œstrogen, 458

McDonald M P Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158

Macdonald, Prof R E, and Waterbury, W E Colorimetric Estimation of Citric Acid, 988

Macdonald, W J P (Thompson, D C, and) Radiation Balance at Scott Base, 541

MacDowall, J Geomagnetic Activity at Halley Bay on Disturbed Days, 1543

McDowall, Prof R J S Retirement from the Halliburton chair of physiology in King's College, London, 405 , work of, 405
  Title of professor emeritus of physiology in the University of London conferred on, 508

Macek, Dr K (herausgegeben von Dr I M Hais und) Handbuch der Papierchromatographie, Band I, Grundlagen und Technik, *review* by Dr R Consden, 1436

McEvily, A J (Machlin, E S, and) Atomic Mechanisms of Fracture (Interrelation between Liability to Fatigue Fracture and the Ability of the Crystal to become Deformed by Cross-slip), 325

MacEwan, Dr D M C Clay Minerals (Calculations on Diffraction Effects from Mixed-Layer Structures), 780
  Mineralogical Study on Clays of Japan, *review*, 1439

MacEwan, Dr D M C (Mackenzie, Dr R C, and) Clay Minerals, 779

MacEwan, Dr D M C, and Aragon de la Crux, Dr F Phase Transitions in Interlamellar Films, 1859

McFarland, Prof Larry Z Captive Marine Birds possessing a Functiona Lateral Nasal Gland (Salt Gland), 2030

Macfarlane, Dr G Appointed deputy director of the National Physical Laboratory, 1844 , work of, 1844

McGhie, Andrew, and others Chronic Schizophrenia, *review* by Pro Martin Roth, 487

McGill, A R (Hindwood, K A, and) The Birds of Sydney (County of Cumberland), New South Wales, *review* by Dr J A Marshall, 841
McGinnis, A J, and others Biosynthesis of some Amino-Acids from Sucrose by Germinating Uredospores of Wheat Stem Rust, Race 15B, 1943
McGlashan, M L Thermodynamics (Experimental Thermochemistry), 1607
MacGregor, A C Conservation in the Scottish Highlands (Geology of the Scottish Highlands and Islands), 1529
MacGregor, H I, and others Effect of Thioctic Acid on Gain in Body-Weight by Turkey Poults, 1323
McGregor, O R Free Trade in Land in the Victorian Period, 1916
Machlin, E S, and McEvily, A J Atomic Mechanisms of Fracture (Inter-relation between Liability to Fatigue Fracture and the Ability of the Crystal to become Deformed by Cross-slip), 325
Maciejewska-Potapczyk, Dr W Influence of Kinetin, β-Indoleacetic Acid and Gibberellic Acid on Nuclease Activity of Bean (*Phaseolus vulgaris*) Hypocotyls, 557
McIlwain, Carl (Rothwell, Pamela, and) Satellite Observations of Solar Cosmic Rays, 138
McIlwain, Prof Henry Biochemistry and the Central Nervous System, second edition, *review* by Dr G B Ansell, 1261
McIntosh, S A, and others A Modified Rotating-Sector Method of Measuring Kinetic Chain Lifetimes, 266
McKay, Prof R *Obituary* of Prof M Caffrey, 1359
McKenzie, D A Elected honorary president of the Society of Applied Bacteriology, 683
McKenzie, D S, and Swettenham, Brig N A M Biomechanics (Provision of Workable Substitutes for Missing or Defective Limbs), 513
McKenzie, Dr H A At the Second Australian Spectroscopy Conference (Difference Spectra in Acid Solutions and in Urea Solutions of Bovine Serum Albumin, Ovalbumin and Conalbumin), 1195
  Structure and Chemistry of Proteins (Enzymes and Globular Proteins), 1277
Mackenzie, Dr R C, and MacEwan, Dr D M C Clay Minerals, 779
Mackenzie, Dr R C (Mitchell, B D, and) Clay Minerals (A Controlled-Atmosphere Differential Thermal Analysis Apparatus), 780
McKenzie, R M Ergonomics, its Place in Industry, B A 21
McKinlay, A C M, and others Summary of the Geology of Tanganyika, Part I, Introduction and Stratigraphy, 1688
Mackle, H Thermodynamics (Experimental Thermochemistry), 1707
McLaughlin, Dr John J A, and others Photoreactive Pigments in Flagellates—Chromoprotein Pigments of some Cryptomonad Flagellates, 1047
McLean, Dr J W, and others Growth Responses to Selenium in Lambs, 251
McLean, Prof R C Biological Laboratory Data *review*, 577
McManus, Dr H Nuclear Forces and the Few-Nucleon Problem (Scattering of Nucleons by Light Nuclei at High Energy), 1113
McManus, W R Relationship between *p*H and Volatile Fatty Acid and Diversion of Saliva from the Actively Fermenting Rumen of Sheep, 1572
McMaster, Marjorie H, and others Specific Inhibition of Anti-Rh Serum by 'Unnatural' Sugars, 989
McMaster, W J Appointed to a research fellowship in chemistry in the University of Glasgow, 1915
McMenemey, Dr William H The Life and Times of Sir Charles Hastings, Founder of the British Medical Association, *review* by Dr W R Bett, 923
McMullen, R D Insecticidal Action of Ethylene *Bis*dithiocarbamates, 1338
McNarry, L R Distribution of Flares on the Solar Disk Associated with Noise, 806
McNaughton, Dr F L Self-Regulation in Living Systems (Stability in relation to the Human System), 240
M'Neil, Claud M'F, and others Mothicidal Rhodanine Derivatives, 1637
McNeill, P C Thermonuclear Research, 1016
McNeill, P C, and others Ionization Phenomena in Gases (Behaviour of Argon Arcs in Axial Magnetic Fields), 1355
MacNeish, Dr Richard S Preliminary Archaeological Investigations in the Sierra de Tamaulipas, Mexico, 593
McNicoll, W Appointed senior lecturer in civil and mechanical engineering at Queen's College, Dundee, 684
Macquarie Island Transport of Driftwood from South America to Tasmania and (Prof H N Barber, Dr H E Dadswell and H D Ingle), 203
McQuire, A J Limitations Imposed by some Water-borne Preservatives on the Soil Block Test Method for Timber, 1430
McRae, Dr E G At the Second Australian Spectroscopy Conference (Electronically Excited States of Aggregated Identical Molecules), 1195
MacRae, T P Structure and Chemistry of Proteins (Structural Organization of Keratin), 1276
MacRitchie F Structure and Chemistry of Proteins (Surface Denaturation of Proteins), 1277
Macrocosm Microcosm to, *review* by G R Noakes, 214
Macromolecular Components of *Chlorella pyrenoidosa* (Philip Newmark, Jack D Stephens, James B Curry and Gail L Bower), 963
Macromolecular Synthesis in Bacterial Recovery from Ultra-violet Light (C O Doudney), 189
Macromolecules International Symposium on (Commission on Macromolecules of the International Union of Pure and Applied Chemistry), 1689
Macromolecules (Cationic) Reduction of Toxicity of, by Complexing with Anionic Derivatives of Synthetic Polyglucoses (P T Mora, B G Young and M J Shear), 431
Macromolecules (Non-enzymic) Reaction-directing Properties of—Pyrogallol Oxidation in the System Iron (III)–Cellulose (N S Goodman and S M Siegal), 53
Macrophage System Assessment of the Phagocytic Activity of the (Prof D L J Bilbey and Dr H Salem), 992
  Influence of Sulphur Dioxide Inhalation on the Phagocytic Activity of the (Prof, D L J Bilbey and Dr H Salem), 722
Macrophages containing *Eimeria tenella* Protein Synthesis in (Dr G A Gresham and J G Cruickshank), 1153
McSweeney, G P, and others Incorporation of DL-[2-^{14}C] Mevalonic Acid Lactone into Polyisoprene, 268, *erratum*, 772
McTaggart, F K (Blackwood, J D, and) A New Approach to Carbon Gasification, 447
McTaggart-Cowan, Patrick D Appointed director of the Meteorological Branch of the Canadian Department of Transport, 1105, work of, 1105
Mactra stultorum Linne (Lamellibranchiata) Shell and Siphon Regeneration in (L Birkett and R J Wood), 1075
McTurk, G (Clarke, J W, and) Some Experiments on Rice's Blue Material, 2014
McVaugh, Rogers Flora of Peru, *review*, 666
McWilliam, Dr I G Gas Chromatography (Comparison of Detectors for Gas Chromatography), 328
Macy (Josiah), Jr Foundation Grants, 683
Madagascar A Zoological Survey of (Dr Renaud Paulian), 1387
Maddock, Dr A G, and Vargas, J I Influence of Crystal Defects on the Szilard-Chalmers Process in Solids, 1931
Maddock, Dr A G (Claridge, R F C, and) Annealing of Recoil Damage by Ultra-Violet Light, 1932
Maddy, Dr A H Detection of 2 4-Dinitrophenyl Amino-Acids on Paper Chromatograms, 1397
Maetz, J, and others Natriferin, a New Hormonal Principle in the Neurohypophysis of certain Vertebrates, 1236
Magasanik, B Specificity in Protein Biogenesis (Control of the Synthesis of Specific Proteins), 1198
Magat, M Macromolecules (Ionic Polymerization initiated by Ionizing Radiation), 1689
Maggio Rachele, and Monroy, Alberto An Inhibitor of Cytochrome Oxidase Activity in the Sea Urchin Egg, 68
Magic Science and (John Cain), 1535
Magic and Experimental Science A History of (Prof Lynn Thorndike), Vols 7 and 8, The Seventeenth Century, *review* by Dr V A Eyles, 1899
Magistrelli, F (Allen, J E, and) Ionization Phenomena in Gases (Experiments on the Plasma Sheath Transition in the presence of a Magnetic Field) 1357
Magistretti, M J, and others N-Substituted 7-Methoxy-8-Aminomethylchromones and Flavones—New Brain-Stem Stimulants, 362
Magma Liquation Differentiation in (V I Lebedinsky), 1025
Magma (Basic) Deposition of Trace Elements in (R J P Williams), 44
Magnesium Absorption of, in the Large Intestine of the Calf (Dr R H Smith), 821
  The Metallurgy of, *review* by Dr J W Martin, 486
Magnesium (Labelled) Excretion of, by the Sheep (D C Macdonald, A D Care and B Nolan), 736
Magnesium and its Alloys The Physical Metallurgy of (Prof G V Raynor), *review* by Dr J W Martin, 486
Magnesium in Blood Serum Determination of, by Atomic Absorption Spectroscopy (Dr J B Willis), 186
Magnesium in High-Purity Aluminium Analysis for (C A Youngdahl and F E DeBoer), 54
Magnesium in the Insulin-Sensitivity of the Rat Diaphragm *in vitro* Rôle of (Dr Gangagobinda Bhattacharya), 1401
Magnesium Deficiency in Lambs on a Diet containing Roughage Experimental Production of (Dr D M McAleese and Dr R M Forbes), 2025
Magnesium Ions Determination of the Interaction of Deoxyribonucleate and, by means of a Metal Ion Indicator (Joseph Shack and Barbara S Bynum), 635
Magnesium Uptake from Foliar Applications of its Salts on Apple Rôle of the Anion in (M Allen), 995
Magnesium (Potassium, Calcium and) Effect on the Groundnut of Variations in Supply of (Dr R Comber), 1003
Magnetic Effects resulting from Two High-altitude Nuclear Explosions (J A Lawrie, V B Gerard and P J Gill), B A 34
Magnetic Equator Possible Asymmetry in the Daily Range of the Geomagnetic Vertical Intensity around the (Dr C A Onwumechilli), 51
Magnetic Field associated with a Great Solar Flare (Dr Robert Howard, Dr Thomas Cragg and Dr Horace W Babcock), 351
Magnetic Field (Earth's) Possible Reversals of the, in the Jurassic Period (Dr R W Girdler), 540
Magnetic Moments (Principal), of Co^{++} Ions Temperature Variation of the, and the Asymmetry of the Crystalline Electric Field in Cobalt Acetate Tetrahydrate (Dr Bhagawati Charan Guha), 50
Magnetic Processes The Visualization of (Prof L F Bates), B A 41
Magnetism Some Aspects of (Institute of Physics Conference on), 322
Magnetism (Reverse Thermo-Remanent) Exchange Interaction as a Cause of (T Nagata and S Uyeda), 890
Magnetization (Natural Remanent), of Pre-Cambrian Gneiss of Ongul Islands in the Antarctic (T Nagata and Y Shimizu), 1472
Magnetohydrodynamics, *review* by Prof V C A Ferraro, 1672
Magni, G Cytoplasmic Inheritance (Sex Ratio in *Drosophila*), 1012
Magnus, K E (Hassall, Prof C H, and) Monamycin, a New Antibiotic, 1223
Mahesh, Virendra B, and Ulrich, Frank Distribution of Enzyme Systems responsible for Steroid Metabolism in Different Tissues and Sub-cellular Fractions, 1147
Maheshwari, Prof P Awarded the Birbal Sahni Medal for 1958 of the Indian Botanical Society, 95
  Elected a member of the Botany Section of the Leopoldina Academy of Natural Sciences, 595
Mahler, Dr Robert, and others Liver Glucosyl Oligosaccharides and Glycogen—Carbon-14 Dioxide Experiments with Hydrocortisone, 1380
Maier, Van W Fast Chemical Reactions in Solution (Use of the Ultrasonic Technique to Study Association Reactions), 1453
Main Stages of Social Evolution in Man (Dr Max Pettersson), 481
Mainardi Danilo Immunological Distances among some Gallinaceous Birds, 913
Maintenance of Parathyroid Tissue Fragments on Agar Substrates (Dr John H Wallace Dr George J Hill, Jean M McCarthy and Dr John R Brooks), 1734
Maintenance of Pregnancy in Ovariectomized Ewes by means of Progesterone (N W Moore and L E A Rowson), 1410

Maintenance of Semipermeability of Plant Cell Membranes in the Absence of Metabolic Energy Supply (Dr B Ginzburg) 1073
Maisin, J F H Biological Effects of Low Doses of Ionizing Radiations (Small Doses of Radiation could themselves Protect against the Damaging Effect of Larger Doses), 1112
Maize Coleoptile Cell Walls A Partial Chemical Characterization of, prepared with the Aid of a Continually Renewable Filter (Prof Aleksander Kivilaan, Teofila C Beaman and Robert S Bandurski), B A 81
Maize Virus (New) Needle Transmission of a (Dr I Harpaz), B A 77
Maizels, Prof M Calcium Ions and the Permeability of Human Red Cells, 366
Majewski, Dr A Polar Front Survey (Hydrography—Baltic and North Seas), 1183
Majumder, S K, and others Insecticidal Effects of Activated Charcoal and Clays, 1165
Makela, Dr O A Method for distinguishing between α- and β-Glycosides by the use of Plant Haemagglutinins (Lectins), 111
Maker Man the—a History of Technology and Engineering (Prof R J Forbes), *review* by Dr A R Hall, 921
Malacological Society, Netherlands Twenty-fifth Anniversary, 1612
Maladies of Hevea in Malaya (Roger N Hilton), *review* by R W G Dennis, 1976
Malaya Maladies of Hevea in (Roger N Hilton), *review* by R W G Dennis, 1976
Male Aged Rats Effect of Prolonged Thyroid Administration on (Prof John F Lhotka, Lloyd Glenn McArthur and Arthur A Hellbaum), 1149
Male Rat Effect of Sexual Maturation and Castration on the Sex Chromatin Pattern in the (St Zsifkovits, Ch Mehes and C Jobst), 1239
Maleic Acid Significance of Lactose in the Diet in Aminoaciduria caused by (Stefan Angielski and Jerzy Rogulski), 276
Malformation (Floral), in *Panicum antidotale* caused by a Species of *Eriophyses* (Dr V M Desai and Dr M J Thirumalachar), 1586
Malies, H M Applied Microscopy and Photomicrography, *review* by Dr S Bradbury, 117
Malignant Change with Deoxyribonucleic Acid from Rat Sarcoma and Hepatoma An Attempt to produce (Dr J G Bearn), 824
Malinow, Dr Manuel Rene, and others The C_{17}-OH Group of Œstradiol—Relationships between its Anti-Atherogenic and Endocrine Actions, 1720
Malkin, Dr T Synthesis and Properties of 1-Glyceryl-2-*myo*-inosityl Phosphate, 789
Malkin, Dr T (Davies, J H, and) Synthesis of 1-Glyceryl-2-*myo*-inosityl Phosphate (Synthesis and Properties of 1-Glyceryl-2-*myo*-inosityl Phosphate), 789
Mallows, C L (Barton, D E, and) Estimation of Linear and Non-Linear Structural Relations, 1086
Maltback, J C Appointed lecturer in mechanical engineering at the University of Birmingham, 1915
Maltby, Per Correlation between the Intensity of the Umbra of Sunspots and Enhanced Radiation on 200 Mc /s, 1391
Malurkar, S L Retirement from the directorship of the Colaba and Alibag Observatories, 1611, work of, 1611
Malvern Hills Preservation of the, 1272
Mammal Society of the British Isles Conference at Bristol, 29
Mammal Society, Australian Inaugural Meeting, B A 16
Mammalian Alimentary Tract Glycosidases in the (J Conchie and D C Macdonald), 1233
Mammalian Cells in Culture X-Ray Damage and Recovery in (M M Elkind and Harriet Sutton), 1293
Mammalian Erythrocytes Metabolic Changes Induced in, by Whole-Body X-Irradiation (Prof D A Rappoport and B W Sewell), 846
Mammalian Joints Experimental Evidence for Weeping Lubrication in (Mechanism of Animal Joints), (P R Lewis and Dr C W McCutchen), 1285
Mammalian Neuromuscular Junction Post-activation Changes at the (J I Hubbard), 1945
Mammals North American, *review* by Peter Crowcroft, 1524
  Sex Chromatin ('Chromoleme') in the Purkinje Nerve Cells of some (Nylceo Marques de Castro and Wilson da Silva Sasso), 293
Mammals of Banff National Park, Alberta (A W Banfield), 594
Mammals of the Belgian Congo, 155
Mammals of North America (Prof E Raymond Hall and Dr Keith R Kelson), *review* by Peter Crowcroft, 1524
Mammals (British), and some Others (Dr J F D Frazer), 29
Mammals (Eutherian) Chromosomal Evolution in (Prof Robert Matthey), 1329
Mammals (Laboratory) Visual Pigments of some Common (Dr C D B Bridges) 1727
Mammary Glands (Total), of the Mouse Organ Cultures of (Dr F J A Prop), 379
Mammiferes (Grands) Écologie et Biologie des (Primates, Carnivores, Ongulés), (Jacques Verschuren), (Exploration du Parc National de la Garamba, Mission H de Saeger, Fasc 9), 155
Mammoth Tobacco (Maryland) Isolation of Fatty Alcohols with Plant-Growth Promoting Activity from (Dr A J Vlitos and Dr D G Crosby), 462
Man Biological Half-Life of Radioiron in (R Oliver and Dr L G Lajtha), 1882
  Effect of Sorbitol on the Urinary Excretion of some B Vitamins in (J D Watson and Prof John Yudkin), 911, *errata*, 1362
  Extrahepatic Metabolism of Ethanol in (Dr J A Larsen), 1236
  Main Stages of Social Evolution in (Dr Max Pettersson), 481
  The Proper Study of Mankind is (Sir James Gray), B A 35
  A Religion of, *review* by Dr D J McCracken, 1571
  Rivers and (Dr Robert Brittain), *review* by Dr E H Brown, 1977
  A Seasonal Rhythm in the Presentation of Bone Sarcoma in (Dr C H G Price), B A 76
  The Study of, B A 1
Man the Maker—a History of Technology and Engineering (Prof R J Forbes), *review* by Dr A R Hall, 921
Man and the World's Fauna (Dr L Harrison Matthews), B A 43
Man-made Drugs, *review* by F R Batchelor, 1597
Man-power to Atomic Power From (Victor Wall), 1535
Man-power in Industry Efficient Use of (Report of an inquiry by the National Joint Advisory Council), 25
Man-power (Scientific and Engineering), in Great Britain, 1959 (Report of the Committee on Scientific Man-power of the Advisory Council on Scientific Policy), 1982
Man-power Problems (Scientific), in Britain, 1971
Man-powered Aircraft Prize of £5,000 offered by Henry Kremer for the first successful flight of a, 1534
Management in India, 1913
Management Grassland, *review* by Dr W Davies, 1675
  Relationships in Industry—some Changing Concepts in (British Institute of Management and the Ministry of Labour Conference on), 156
Management, British Institute of Cost of Labour Turnover, 1110
Management, British Institute of, and the Ministry of Labour Conference on Relationships in Industry—some Changing Concepts of Management, 156
Management of Salt-affected Soils Diagnosis, Improvement and (Unesco Middle-East Science Co-operation Office Regional Training Course on), 1778
Management Conference Proceedings of the Fifth (Ahmedabad Textile Industry's Research Association), 1913
Management Development, a Systematic Approach to the Provision of Supervisors and Managers (F I de la P Garforth), 319
Management Problems in Under-developed Countries, 483
Management and Underdeveloped Territories (Political and Economic Planning, Broadsheet No 434), 483
Managers Management Development, a Systematic Approach to the Provision of Supervisors and (F I de la P Garforth), 319
Mancini, Dr E E, and others Histological Localization of Fluorescent Thyroid-stimulating Hormone in Rat Tissues, 1733
Mandel, Dr L Fluctuation Phenomena and Stochastic Processes (Problem in which the Approach of the Quantum Theory produced a Substantial Simplification), 510
Mandel, Prof Paul, and Chambon, Pierre Biological Effects of Low Doses of Ionizing Radiations (Ribonucleic Acid Synthesis in Rat Spleen after Whole-body Irradiation), 1112
  A New Approach to the Mechanism of Mutations, 1501
Mandel, Prof Paul, and others Distribution of Nucleic Acids among Different Stable *L* Forms of *Proteus P* 18, 566
Manganese Dioxide Action of, on Simple Carbohydrates (Dr J L Bose, Dr A B Foster, Prof M Stacey and Dr J M Webber), 1301
Mangels and Swedes Fodder Beet, (National Institute of Agricultural Botany Leaflets on), 1777
Mani, Dr N At the 139th Annual Meeting of the Swiss Society for Natural Sciences (Baldasar Heseler's Eye-witness Account of Vesalius's first Public Anatomy Lecture), 1455
Mankind The Proper Study of, is Man (Sir James Gray), B A 35
Manley, Prof Gordon, and others Statement on Biological and Chemical Warfare, 1018
Manley, Prof Thomas R Polymerization of Phosphonitrilic Chlorides, 899
Manly, Dr Brenda Appointed a lecturer in zoology at the University of Birmingham, 684, 1362
Mann, D J O Awarded a Mond Nickel Fellowship for 1959, 1272
Mann, Dr F G Heterocyclic Chemistry, *review*, 216
  Chemistry of Phosphorus, *review*, 389
  Heterocyclic Chemistry, *review* 1758
Mann, John W (Giles, jun, Lester A, and) Oil Pollution of the Sea (Recommendation that the United States accept the 1954 Convention), 950
Mann, Dr T Current Research on Reproduction and Fertility, *review*, 1434
Mannheim, Herbert (Wilkins, L T, and) Personnel Management and Technological Change (Operational Problems of the Borstal System), 1615
Manning, R, and others The Inner Solar Corona during June 1959, 1308
Mansfield, Dr E H Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 858, work of, 858
Mansi, W, and others Myxomatosis—Present Position and Future Prospects in Great Britain, 1179
Manson, L A, and others Effects of Deuterium Oxide on the Synthesis of *T5* and *T7* Bacteriophages, 1167
Manson, Dr W The N-Terminal Amino-Acids of α-Casein, 1393
Mansonioides Mosquitoes Age Determination in (R H Wharton), 830
Mansur, Lawrence C (edited by Dr Heinz Fischer, and) Conference on Extremely High Temperatures (Sponsored by the Electronics Research Directorate of the United States Air Force Cambridge Research Center, Boston, 1958), *review* by Dr T E Allibone, 83
Mantle (Earth's) A Bore-Hole to the—AMSOC's Mohole (Gordon Lill and Willard Bascom), 140
Manton, I Origin and Dispersal of Flowering Plants, 1200
Manuel, S (Chevallier, A, and) Biological Effects of Low Doses of Ionizing Radiations (Drop in the Ascorbic Acid Content of almost all Tissues, particularly the Spleen), 1112
Mapping Vegetation (International Society for Plant Geography and Ecology International Symposium on), B A 23
Maps Metallogenic (Prof S I Tomkeieff), 1693
Marchant Dr R H Specificity of the Tryptophan Peroxidase-Oxidase Enzyme System, 1711
Marchessault, R H, and others Liquid Crystal Systems from Fibrillar Polysaccharides, 632
Marconi Premium of the British Institution of Radio Engineers awarded to Dr Morton B Prince and M Wolf, 857
Marcou, D (Rizet, G, and) Cytoplasmic Inheritance (Barrage and Senescence in *Podospora*), 1012
Marcovich, — Biological Effects of Low Doses of Ionizing Radiations (Induction of Lysogenic Bacteria), 1113
Marcy, René, and others Preparation of a Highly Purified Sample of the Urinary Gonadotrophin, 983
Margenau, H Ionization Phenomena in Gases (Broadening of Spectral Lines by Stark Effects), 1357
Margolis, M A (Dole, S H, and) Chemistry of Propellants (Sources, Availability and Estimated Cost of Propellants), 778
Marine Biological Ashes Some Activation Analyses of Six Trace Elements in (R Fukai and Prof W W Meinke), 815
Marine Biological Association Grant of £1,422 to the University of Leeds, for research on the electron microscopy of marine flagellates, 1108
Marine Biological Research Future, *review* by Dr J A Allen, 215

Marine Biological Station on Heligoland New (Dr J N Carruthers), 400
Marine Biology Perspectives in—a Symposium held at Scripps Institution of Oceanography, 1956 (edited by A A Buzzati-Traverso), *review* by Dr J A Allen, 215
Marine Birds (Captive), possessing a Functional Lateral Nasal Gland (Salt Gland), (Prof Larry Z McFarland), 2030
Marine Engines Exhibition of Working Models of (Liverpool Public Museums), 1534
Marine Gastropods Defensive Acid-Secretion in some (Dr T E Thompson), 1162
Marine Red Alga A Free-Floating (Dr H B S Womersley and Dr R E Norris), 828
Marine Research The Need for, *review* by Dr F S Russell, 129
Marine Standing Crops Proximate Analysis of (Dr T R Parsons and Dr J D H Strickland), 2038
Marini, Mario A, and Hess, Prof George P Reactivity and Interrelationship of Intermediates in the Hydrolysis of *p*-Nitrophenyl Acetate Catalysed by Chymotrypsin, 113
Marini-Bettolo, G B, and others (edited by) Curare and Curare-like Agents, *review* by Dr Marthe Vogt, 1093
Marital Fertility in England and Wales (Prof E Grebenik), 1035
Mark, Prof H Recent Progress in Polymer Chemistry (Fourth Baekeland Memorial Lecture), 156
  Macromolecules (New Condensation Polymers), 1690
Markets (Foreign) British Books and, 605
Marlin (Black), in British East African Waters (F Williams), B A 78
Marples, Ernest Ergonomics, its Place in Industry, B A 20
Marr, A G M Structure and Chemistry of Proteins (Fractionation of Serum Proteins on 'DEAE-cellulose'), 1277
Marrable, A W Variations in Early Cleavage of the Zebra Fish, 1160
Marriage and Divorce Statistics (Demographic Yearbook 1958, Special Topic), (United Nations), *review*, 1525
Marrow (Bone) Therapy Interstrain Ovarian Transplantation in Lethally Irradiated Mice after (Prof W St Amand and L H Smith), 1503
Marrow (Foreign Bone), in Lethally X-irradiated Mice Abrogation by Injected Mouse Blood of Protective Effect of (L J Cole and R M Garver), 1815
Marrow (Guinea Pig Bone) Cells which Synthesize Deoxyribonucleic Acid in, during Recovery from Whole-Body γ-irradiation (P F Harris and J H Kugler), 1883
Mars Vegetation on (W, M Sinton), 1612
Marsden, N V B, and Östling, S G Accumulation of Dextran in Human Red Cells after Haemolysis, 723
Marsdenia erecta R Br Sugars of the Glycoside of the Root of (Dr T Baytop, Dr M Tanker, Dr N Oner and Dr S Tekman), 1319
Marsh, J D F (Griffith, Dr R H, and) Contact Catalysis, *review* by Dr E B Maxted, 1262
Marsh, Dr M C New Research Laboratories for the Cambridge Instrument Company, Ltd, 1364
Marshak, Prof R E Nuclear Forces and the Few-Nucleon Problem (The Primary Two-Nucleon Interaction), 1113
Marshall, Dr A J Animal Clocks (Possible Influence of the Internal Rhythm of Reproduction in the Control of Trans-equatorial Migration of Birds), 764
  The Birds of Sydney (County of Cumberland), New South Wales, *review*, 841
Marshall, Dr A J, and others Duration of the Regeneration Period of the Internal Reproductive Rhythm in a Xerophilous Equatorial Bird, *Quelea quelea*, 1659
Marshall, Dr A J, and Serventy, Dr D L Experimental Demonstration of an Internal Rhythm of Reproduction in a Trans-Equatorial Migrant (the Short-tailed Shearwater *Puffinus tenuirostris*), 1704
Marshall, Dr J G, and Rutledge, Dr P V A Higher Hydrogen Peroxide, H_2O_4?, 2013
Marshall, J K Awarded a Nature Conservancy Research Studentship for postgraduate training in ecology (botany), 156
Marshall, K (Hey, G L, and) The Control of Pests and Diseases in Agricultural and Horticultural Crops, *review* by F C Bawden, 1258
Marshall, Dr Royal R Calculation of a 'Cosmic Ray Age' for the Iron Meteorite 'Carbo', 117
Marshall, S M The Open Sea—its Natural History, *review*, 666
Marsilea and certain other Plants Effects of Gibberellic Acid on Juvenility in (Dr A Allsopp), 1575
Martensitic Transformations in Metals and Alloys (Academician G V Kurdjumov), 1450
Marti, H R, and others Estimation of Small Percentages of Foetal Haemoglobin, 1877
Martin, Dr A E Resolution of Wide-range Grating Spectrometers, 975
Martin, Dr A J P Honorary life membership of the Institute of Petroleum conferred on, 327
  Awarded a John Price Wetherill Medal of the Franklin Institute, 857
Martin, Dr B W Appointed reader in applied thermodynamics at the Imperial College of Science and Technology, 322
Martin, Douglas L (MacDonald, D K C, and) Self-Regulation in Living Systems, 239
Martin, Dr F S, and Miles, Dr G L Chemical Processing of Nuclear Fuels, *review* by Dr J E Littlewood, 1346
Martin, G F (Parr, N L, and) Special Ceramics (Measurement of Creep at High Temperature), 1116
Martin, G F, and others Special Ceramics (Silicon Nitride—its Preparation, its Properties as an Engineering Material and its Microstructure), 1116
Martin, Hubert The Scientific Principles of Crop Protection, fourth edition, *review* by F C Bawden, 1258
Martin, Dr J H, and others Strontium-90 in the Australian Environment, 1957-58, 755
Martin, J H A (Tait, Dr J B, and) Polar Front Survey (Hydrography—Volume Transport through the Faroe-Shetland Channel), 1181
Martin, Dr J T Appointed to a readership in chemistry of insecticides and fungicides in the University of Bristol, 410
Martin, Dr J W The Metallurgy of Magnesium, *review*, 486
Martin, R M Toward a Systematic Pragmatics, *review* by F I G Rawlins, 754
Martin, Dr T J Biological Problems arising from the Control of Pests and Diseases, 1101
Marton, L (edited by, assisted by Claire Marton) Advances in Electronics and Electron Physics, Vol 10, *review* by J R Tillman, 1601
Maruyama, Dr Yoshiharu, and others Formation of Streptolysin *S* by Streptococcal Protoplasts, 832
Maryland Mammoth Tobacco Isolation of Fatty Alcohols with Plant-Growth Promoting Activity from (Dr A J Vlitos and Dr D G Crosby), 462
Mascall, Dr E L The Importance of Being Human, *review* by the Very Rev W R Matthews, B A 2
Mascitelli-Coriandoli, E, and Citterio, Dr C Intracellular Thioctic Acid and Coenzyme A following Vanadium Treatment, 1641
Maskell Peace Scholarship for 1959 of the Institution of Mining Engineers awarded to P Hutchinson, 1845
Mason, Prof Brian Principles of Geochemistry, second edition, *review* by Dr S R Nockolds, 1601
Mason, Dr B J (van den Heuvel, A P, and) Habit of Ice Crystals grown in Hydrogen, Carbon Dioxide and Air at Reduced Pressure, 519
Mason, R Energy Transfer with special reference to Biological Systems (Some Possible Instances of Charge Transfer in Proteins), 689
Mason, Dr R G, and Vitousek, Dr M J Some Geomagnetic Phenomena associated with Nuclear Explosions, B A 52
Mason, Dr R J, and others Pleistocene Climatic Significance of Calcretes and Ferricretes, 568
Mass Media of Communication and Scientific Developments, 659
Mass Spectrometer Application of the, to Polysaccharide Chemistry (Dr F A Finan and Dr R I Reed), 1866
Mass (Electron) Ratio of Nucleon Mass and (Prof A J Rutgers), 894
Mass (Nucleon), and Electron Mass Ratio of (Prof A J Rutgers) 894
Mass (Piston), and Bursting Pressure Measurement of the Effects of, on the Motion of a Piston in a Hypersonic Gun Tunnel (B J Belcher), 1207
Massachusetts General Hospital Gift of 1,000,000 dollars from the Joseph P Kennedy, Jr Memorial Foundation, for the establishment of the Joseph P Kennedy, Jr Laboratories for research on Mental Retardation, 594
Massachusetts Institute of Technology Gift of 2,527,500 dollars from Mr and Mrs C H Green of Dallas, Texas, 507
Massey, Prof H S W Nuclear Forces and the Few-Nucleon Problem (Binding Energies and Elastic Scattering of Light Nuclei at Low Energies), 1114
Massive Incorporation of 5-Fluorouracil into a Bacterial Ribonucleic Acid (Dr Jack Horowitz and Prof Erwin Chargaff), 1213
Mast Cell Population of Lung of the Guinea Pig and other Tissues (Dr W G Smith), 1154
Mast Cells (Rat) Release of Histamine from, by Blood treated with Dextran (Dr G T Archer), 1151
Master Builders' Federation (New Zealand), and the New Zealand Institute of Architects Establishment of a Building Research Bureau, 235
Masterman, M Classification, Concept-formation and Language, 1194
Material (Biological) Spectroscopic Identification of Alpha-Emitting Nuclides in (Prof W V Mayneord and C R Hill), 667
Material (Emetic) Production of, by Species of *Fusarium* (Neville Prentice, A D Dickson and Prof J G Dickson), 1319
Material (Gettering) Titanium as a (R L Stow), 542
Material (Periodic Acid-Schiff-Positive), and Alkaline Phosphatase in the Uterine Wall of the Pig during the Sexual Cycle (Rolv Austad and Dr Otto Garm), 999
Materials Relationship between Structure and Physical Properties of (Non-Destructive Testing Group of the Institute of Physics and the Société Française de Métallurgie Discussion on), 1688
Materials (Porous) The Structure and Properties of—Proceedings of the Tenth Symposium of the Colston Research Society held in the University of Bristol, 1958 (edited by D H Everett and F S Stone), *review*, 1525
Materials (Radioactive) Glove Boxes and Shielded Cells for Handling—a Record of the Proceedings of the Symposium on Glove Box Design and Operation held in the Cockcroft Hall, A E R E, Harwell, 1957 (edited by G N Walton), *review*, 1599
Materials (Radioactive Raw) Mineralogy and Geology of (Prof E Wm Heinrich), *review* by Prof C F Davidson, 1262
Materials and Design (Engineering) Conference on New, 1362
Maternal Control of Ovariole Number in the Progeny of the Migratory Locust (F O Albrecht, M Verdier and R E Blackith), 103
Mateu, J Valls, and others Radiomimetic Action of Lipoxidase, 1506
Math Puzzle- (Prof George Gamow and Dr Marvin Stern), *review* by Prof T A A Broadbent, 217
Mathematical Association Annual General Meeting and Conference, 32
  Presidential Address What is Mathematics?—New Answers to an Old Question (Prof M H A Newman), 32
  Discussion on the Report on Mathematics in Secondary Modern Schools, 32
  Election of L D Adams as president, 33
Mathematical Games, 770
Mathematical Methods of Operations Research (Thomas L Saaty) *review* by Prof L S Goddard, 1763
Mathematical Model for Perception and a Theoretical Confusion Function (M Hammerton), 1668
Mathematical Physics at Birmingham, 679
Mathematical Physics at Birmingham The Graduate School in (Prof R E Peierls), 96
Mathematical Society (London) Annual General Meeting, 1533
  De Morgan Medal presented to Sir William Hodge, 1533
  Presidential Address, Some Recent Progress in the Analytic Theory of Numbers (Prof H Davenport), 1533
Mathematical Theory of Compressible Fluid Flow (Richard von Mises), (completed by Hilda Geiringer and G S S Ludford), *review* by Dr W P Jones, 485
Mathematician Reflections of a (Prof L J Mordell), 681
Mathematics Constructivity in—Proceedings of the Colloquium held at Amsterdam 1957 (edited by Prof A Heyting), *review* by Dr Hao Wang, 1435
  What is—New Answers to an Old Question (Prof M H A Newman), 32
Mathematics in Secondary Modern Schools (Mathematical Association Discussion on the Report on), 32

Mathematics (Applied) at Cardiff, 591
Mathematics ('Applied') Surveys in, *review* by D G Kendall, 214
Mathematics (Applied), and Theoretical Physics at Cambridge, 686
Mathematics and Operations Research, *review* by Prof L S Goddard, 1763
Mather, Prof K Genetics and the Origin of Species, 587
Mather, Dr Kirtley F Re-elected president of the American Academy of Arts and Sciences, 410
Matheson, Norman A Absorption of Atmospheric Moisture by Freeze-dried Pork and Fish, 1949
Mathews, Micheline M , and Sistrom, W R Function of Carotenoid Pigments in Non-Photosynthetic Bacteria, 1892
Mathewson, Prof J H Experiments on Automobile Collisions, 237
  A Simulator for Research on Driver Behaviour, 237
Mathieson, A McL (Fridrichsons, J , and) Structure and Chemistry of Proteins (Three-dimensional Structure of Toluene-*p*-sulphonyl-L-prolyl-L-hydroxyproline Monohydrate), 1276
Mathieson, A R Appointed lecturer in the chemistry of high polymers, in the Department of Textile Industries in the University of Leeds, 1108
Matrix Algebra in Structural Analysis, *review* by R K Livesley, 1600
Matsui, Prof Toshitaka, and Kuwajima, Yoshio Formation of the Toxoid of Histamine Sensitizing Factor in *Bordetella pertussis*, 199
Matsushita, Dr S Geomagnetic and Ionospheric Phenomena associated with Nuclear Explosions, B A 33
Matsuura, Prof F (Hashimoto, K , and) Two Haemoglobins in Chum Salmon, 1418
Matter The Steady-Rate Universe and the Deduction of Continual Creation of (Prof V A Bailey), 537 , (Prof G Bondi), 537
Matter (Organic), of a Podzol Soil Oxygen-containing Functional Groups in the (J R Wright and J Schnitzer), 1462
Matter (Soil Organic) Titration Curves of (R S Beckwith), 745
Matter, Earth and Sky (Prof George Gamow), *review* by G R Noakes, 214
Matthews, H I , and others Dislocation Arrangements in Molybdenum, 356
Matthews, J J , and others Ionization Phenomena in Gases (Behaviour of Argon Arcs in Axial Magnetic Fields), 1355
Matthews, Prof J R Special number (Vol 38) of the *Transactions* of the Botanical Society of Edinburgh published as a tribute to, on his seventieth birthday, 518
Matthews, Dr L Harrison Man and the World's Fauna (Presidential Address to Section D (Zoology) of the British Association for the Advancement of Science), B A 43
  Animal Clocks, 763
Matthews, P T The Physics of Elementary Particles, *review*, 1677
Matthews, R E F Turnip Yellow Mosaic Virus Nucleoprotein Particles with Differing Biological and Physical Properties, 530
Matthews, Very Rev W R The Importance of Being Human, *review*, B A 2
Matthey, Prof Robert Chromosomal Evolution in Eutherian Mammals, 1329
Mattingly, P F Evolution of Host–Parasite Relationships (Complete Restriction of Human and Simian Malaria to Anopheline Vectors), 763
  Animals Clocks 765
Mattock, Dr G Alkali Ion Determinations by means of Glass Electrodes, 1616
Maturation (Sexual), and Castration Effect of, on the Sex Chromatin Pattern in the Male Rat (St Zsifkovits, Ch Medes and C Jobst), 1239
Matuyama, Eitaro Effects of Heating on X-Ray Diffraction by Carbons, 544
Matze, J , and others Action of Anhydrous Formic Acid on Peptides and Proteins, 2015
Mautner, Prof M At the ninth International Starch Convention (New Method for the Continuous Production of Glucose by the Acid Hydrolysis of Starch), 514
Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure (United States National Bureau of Standards, Handbook 69), 939
Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure Maximum Permissible Body Burdens and (United States National Bureau of Standards, Handbook 69), 939
Maximum (Polarographic), of Copper Effect of Polycyclic Aromatic Hydrocarbons on the (C E Searle), 1716
Maxted, Dr E B Catalysis, *review*, 750
  Contact Catalysis, *review*, 1262
Maxwell (Clerk) Premium of the British Institution of Radio Engineers awarded to C Powell and D A Hendley, 957
Maxwell, I R , and others (edited by) The Economics of Nuclear Power, including Administration and Law, Vol 2, *review* by R Brightman, 1673
Maxwell I S Derbyshire Place-Names, *review*, 1767
May, B R , and Smith, D E The Continued Progress of Satellite 1958δ2 (*Sputnik III*), 765
May, E R W , and others Special Ceramics (Silicon Nitride—its Preparation, its Properties as an Engineering Material and its Microstructure), 1116
May, John Cecil *Obituary* by Sir Joseph Hutchinson, 589
May's Chemistry of Synthetic Drugs, revised and re-written by Dr G Malcolm Dyson, in consultation with Dr Percy May, fifth edition, *review* by F R Batchelor, 1597
Mayer, A M Joint Action of Gibberellic Acid and Coumarin in Germination, 826
Mayer, Jean, and others Increased Circulating Insulin-like Activity in Obese-Hyperglycaemic Mice, 61
Mayer, J E Thermodynamics (Phase Changes in Condensed Systems), 1608
Mayneord Prof W V , and Hill, C R Spectroscopic Identification of Alpha-Emitting Nuclides in Biological Material 667
Mays, Dr W Chance and Probability (Chance and Uncertainty), 498
Mazurek, J H (Mutchmor, J A , and) Chemical Changes associated with Diapause in the European Corn Borer, *Ostrinia nubilalis* (Hbn) (Lepidoptera Pyralidae), 1077
Mead, Dr Margaret An Anthropologist at Work—Writings of Ruth Benedict, *review* by Prof E E Evans-Pritchard, 301
Meals (School) in Asia and the Far East, 420
Means of Measuring the Carbon Dioxide Output of Individual Insects The Infra-Red Gas Analyser as a (Dr A G Hamilton), 367
Measured by Electron Spin Resonance Free Radicals in X-Rayed Seeds of High and Low Water Content, as (Dr W Klingmuller, Dr G R Lane, M C Saxena and Dr D J E Ingram), 464
Measurement of Asbestos Dust Concentrations with the Long-Running Thermal Precipitator (Dr C G Addingley and Dr R Gaze), 715
Measurement of Cosmic Noise at Low Frequencies above the Ionosphere (J P I Tyas, C A Franklin and A R Molozzi), 785
Measurement of the Effects of Piston Mass and Bursting Pressure on the Motion of a Piston in a Hypersonic Gun Tunnel (B J Belcher), 1207
Measurement of Grassland Productivity (Sixth Easter School in Agricultural Science at the University of Nottingham School of Agriculture), 154
Measurement of Inhibition by Azide in Biochemical Assay Systems involving Nitrite Estimation by Diazotization (Dr E J Hewitt and D G Hallas), 1485
Measurement of Intergranular Diffusion in a Silicate System—Iron in Forsterite (Prof John J Naughton and Yasuo Fujikawa) B A 54
Measurement of the Oxygen Isotopes Ratio in Fossil Calcareous Organisms Determination of the Temperatures of Ancient Seas by the (Y A Birstein) 1025
Measurement of the Rate of Growth of Wool using Cystine labelled with Sulphur-35 (A M Downes and A G Lyne), 1884
Measurement by Spectrofluorimetry Photolysis of Thionine in Rigid Medium—(Dr C A Parker and W T Rees), 1223
Measurement of the Thickness of the Helium Film (Prof L C Jackson), 954
Measurement of Values (Prof L L Thurstone), *review* by Prof Ll Wynn Jones 1010
Measurement (Accurate) An Image-Splitting Microscope for (J Dyson), 1561
Measurement (Film Thickness), by Beam Interferometry Substrate Damage in (Prof G David Scott), 354
Measurement (Productivity), in Great Britain (T E Easterfield), 592
Measurements of Temporal Adaptation to Spatial Detail Vision (A J Seyler and Z L Budrikis), 1215
Measurements (Micropulsation), in California and Alaska (W H Campbell and B Nebel), 628
Measurements (Absorbancy), on Liver and Kidney Cells (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Dr Bo Thorell and Prof Britton Chance), 934
Measurements (Absorbancy), on the *Neberkern* (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Dr Robert P Perry, Dr Bo Thorell, Dr Lennart Åkerman and Prof Britton Chance), 929
Measurements (Fluorescence), of Mitochondrial Pyridine Nucleotide in Aerobiosis and Anaerobiosis (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Prof Britton Chance and Dr Bo Thorell), 931
Measurements (Radiation), to 658,000 km with *Pioneer IV* (Prof James A Van Allen and Louis A Frank), 219
Measurements (Some), of Background Gamma-Radiation in Leeds during 1955-59 (Prof F W Spiers), 1680
Measures of the Polarity of Benzene and Borazole Substituents Intermolecular Distances and Diamagnetic Anisotropy in Crystals as (Dame Kathleen Lonsdale), 1060
Measuring the Carbon Dioxide Output of Individual Insects The Infra-Red Gas Analyser as a Means of (Dr A G Hamilton) 367
Measuring Intracellular Activities of Sodium and Potassium Glass Micro-Electrodes for (Dr J A M Hinke), 1257
Measuring Kinetic Chain Lifetimes A Modified Rotating-Sector Method of (Dr W I Bengough, S A McIntosh and R A M Thomson) 266
Mechanical Engineers, American Society of Colloquium on Mechanical Impedance Methods for Mechanical Vibrations, 1958 (edited by R Plunkett), *review* by Prof R E D Bishop, 1764
Mechanical Engineers, Institution of Symposium on Biomechanics, 512
  Discussion on the Computer in Production, 1613
Mechanical Impedance Methods for Mechanical Vibrations—Colloquium presented at the Annual Meeting of the American Society of Mechanical Engineers, 1958 (edited by R Plunkett), *review* by Prof R E D Bishop, 1764
Mechanical Vibrations Mechanical Impedance Methods for—Colloquium presented at the Annual Meeting of the American Society of Mechanical Engineers, 1958 (edited by R Plunkett), *review* by Prof R E D Bishop, 1764
Mechanics Theoretical and Applied (Indian Society of Theoretical and Applied Mechanics Fifth Congress on) 1192
Mechanics (Theoretical), at Southampton, 590
Mechanics (Theoretical and Applied), Indian Society of Fifth Congress on Theoretical and Applied Mechanics, 1192
Mechanism Behavior of Enzyme Systems, an Analysis of Kinetics and (Dr John M Reiner), *review* by Dr J B Chappell, 388
  Sympathetic Postganglionic (Prof J H Burn and M J Rand), 163
Mechanism of Animal Joints—Sponge-hydrostatic and Weeping Bearings (Dr C W McCutchen), 1284 , Experimental Evidence for Weeping Lubrication in Mammalian Joints (P R Lewis and Dr C W McCutchen), 1285
Mechanism of the Antidiuretic Effect of Vasopressin (Dr Tsutomu Kashiwagi) 991
Mechanism of Anti-Knock (Dr A B Callear and Prof R G W Norrish), 1794
Mechanism of the Atherogenic Action of Excess Hydrocortisone (Dr Henry Grossfeld) 38
Mechanism of Atom Recombination (Prof G Porter and Dr J A Smith), 446
Mechanism of Autoregulation of Renal Blood Flow (Dr Allen M Scher) 1322
Mechanism of Electrode Reactions at the Mercury Electrode Influence of Platinum in Mercury on the (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus) 1795
Mechanism of Hormone Action (Prof Aaron B Lerner), 674
Mechanism of Immunological Unresponsiveness (Prof Charles F Crampton, Fred R Frankel and J L Rodeheaver) 873
Mechanism of Inactivation of Glucose-6-phosphate Dehydrogenase in Human Erythrocytes (Glucose-6-phosphate Dehydrogenase and Human Erythrocytes), (Dr Paul E Carson, Stanley L Schrier and Robert W Kellermeyer), 1292
Mechanism of Mutations A New Approach to the (Prof Paul Mandel and Pierre Chambon), 1501
Mechanism of Paraffin-Detergent Interactions in Aqueous Systems Solid State Rheological Study of the (F J Radd and L H Crowder), 443
Mechanism (Biochemical), of Lesion Formation in Virus-infected Plant Tissues (Dr F Solymosy, Dr G L Farkas and Dr Z Kiraly), 706

Mechanism (Feeding), of *Tilapia nigra* (Peter J Whitehead), 1509
Mechanism (A Heat-Loss), involving the Habenular, Interpeduncular and Dorsal Tegmental Nuclei (B G Cragg), 1724
Mechanism (Possible), of Cysteine Protection against Radiation Cataract (A Pirie and L G Lajtha), 1125
Mechanism (Sliding Filament Contractile), in Tonic Smooth Muscles of Lamellibranch Molluscs Evidence for a (Dr Jean Hanson and Dr J Lowy), 286
Mechanism (Strength Impairment), of Glass in Aqueous Systems (Frederick J Radd and Donald H Oertle), 976
Mechanisms of Resistance of Adult Houseflies to the Insecticide Dieldrin (F P W Winteringham and A Harrison), 608
Mechanisms (Atomic), of Fracture (United States National Academy of Sciences—National Research Council Conference on), 324
Mechanisms (Scatter), in Tropospheric Radio Propagation Inadequacy of (P C M de Belatini), 1558
Mechanisms (Sensory) Haemoglobin and, *review* by P A Merton, 1092
Mechanisms (Transfer), of Electronic Excitation (Prof Th Forster), 688
Mechanisms (Two Enzymic), for Hydrogen Transport by Phenolic Œstrogens (Dr H G Williams-Ashman, M Cassman and Margaret Klavins), 427
Mechsner, Kl (Welte, Prof E, and) Biological Action of Potassium-40 in Naturally Occurring Potash Salts, 1958
Medal for Research Work of benefit to Agriculture (Royal Agricultural Society of England), 1450
Medawar, Prof P B Elected an Honorary Member of the American Academy of Arts and Sciences, 410
  The Structure of Science, B A 8
  Awarded a Royal Medal for 1959 of the Royal Society, 1360, 1833, work of, 1833
Media (Biological) Ionized Calcium in (Prof J Ettori and Sybil M Scoggan), 1315
Media (Laboratory) Production of Fungal Arbuscular Organs on (G A Atkins), 1738
Media (Mass), of Communication and Scientific Developments, 659
Media (Porous) Sedimentation Rates Fluidization and Flow through (Colin C Harris), 716
Median Sky Wave Field Strength in Tropical Regions The Calculation of the (W R Piggott), 605
Medical Aspects of Complex Carbohydrates (Prof M Stacey), B A 42
Medical Association (British) The Life and Times of Sir Charles Hastings, Founder of the (Dr William H McMenemey), *review* by Dr W R Bett, 923
Medical Biology and Etruscan Origins Ciba Foundation Symposium on (edited by G E W Wolstenholme and Cecilia M O'Connor), *review* by Madeleine Smith, 1348
Medical Electronics (Electronics and Communications Section of the Institution of Electrical Engineers and the International Federation for Medical Electronics Third International Conference on), 1535
  Bibliography of (prepared by the Medical Electronics Center of the Rockefeller Institute), 1026
Medical Electronics, International Federation for (Electronics and Communications Section of the Institution of Electrical Engineers and the) Third International Conference on Medical Electronics, 1535
Medical History Egypt and Greece in, *review* by Dr Douglas Guthrie, 662
Medical Physics (Biological and) Advances in, Vol 6 (edited by Cornelius A Tobias and John H Lawrence), *review* by Dr N M Blackett, 1766
Medical Research Council Appointment of Sir Hugh Linstead as a member, B A 16
  Appointment of Prof A L Hodgkin and Prof R Milnes Walker as members, 772
  Appointment of Sir Hugh Linstead as House of Commons member, 772
  Grant not exceeding £1,100 to the University of Oxford, for scientific assistance in a study by X-Ray analytical methods of Insulin and related structures, 943, 1273
Medical Research Council (Agricultural Research Council, the), and the Development Commission on Biological (Mon-Medical) Problems of Nuclear Physics Appointment of Sir James Dendy Roberts as chairman of the Joint Committee of the 237
Medical Sciences, Vol 2 (edited by J C Bugher, J Coursaget and J F Loutit), (Progress in Nuclear Energy, Series 7), *review* by Dr N M Blackett, 1766
Medical Sciences, International Organizations of Abnormal Haemoglobins—a Symposium organized by the Council for (edited by J H P Jonxis and J F Delafresnaye), *review* by Dr J A M Ager, 840
Medical-Surgical Building (New), of the Ontario Veterinary College, 695
Medicina Experimentalis, Vol 1, No 1, 1025
Medicine—Mother of the Sciences (Canon Charles E Raven), 1448
Medicine Ancient Egyptian and Cnidian (Robert O Steuer and J B de C M Saunders), *review* by Dr Douglas Guthrie, 662
  Nuclear Energy and, *review* by Dr N M Blackett, 1766
Medina, Heitor, and Bacila, Metry Reversal by Acetylcholine of the Inhibition by Thyroxine of Oxidative Phosphorylation in Guinea Pig Heart Sarcosomes, 1066
Medium (Rigid) Photolysis of Thionine in—Measurement by Spectrofluorimetry (Dr C A Parker and W T Rees), 1223
Medium (Synthetic) *In vitro* Cultivation of Blood Cells of *Drosophila melanogaster* in a (Dr Masakatsu Horikawa and Dr Yukiaki Kuroda), 2017
Medium (Whistler) Telluric Origin of the (Dr Francis S Johnson), 1787
Medulla (Denervated Adrenal) Effects of Reserpine on Secretion from the (L Stjärne and S Schapiro), 2023
Medullary Secretion (Adrenal), of Catechol Amines Effects of 1,4-Dihydrazinophthalazine on Organ Content and (M Bygdeman and L Stjärne), 1646
Medway, Lord Echo-Location among *Collocalia*, 1352
Meek, J M Ionization Phenomena in Gases (Ionization Coefficients), 1354
Meetham, A R Thermodynamics (Physical Constants), 1608
Megakaryocytes (Pulmonary) A Possible Explanation of the Formation of Long Platelets from (Dr J George Sharnoff), B A 75
Megaw, Dr Helen D Ferroelectricity in Crystals, *review* by Dr L E Cross, 6
Megson, Dr N J L Promoted to Deputy Chief Scientific Officer and appointed director of materials, research and development (air) at the Ministry of Supply Headquarters, 232, work of, 232
Mehes, Ch, and others Effect of Sexual Maturation and Castration on the Sex Chromatin Pattern in the Male Rat, 1239
Mehridatta, R C Indications of Glacierization in the Siwalik System in India, 833
Mehrtens, D H (Zakrzewski, J T, and) Use of the Silicon Resistor in the d c Stabilization of Transistor Circuits, 811
Mehta, D R (Amin, A H, and) A Bronchodilator Alkaloid (Vasicinone) from *Adhatoda vasica* Nees, 1317
Meier, Dr Hans A Sex Difference in White Blood Cells of Rats (*WR* Strain), 1082
Meigh, Dr D F Nature of the Olefines produced by Apples, 1072
Meijer, W *Rafflesia arnoldi* in Sumatra, 506
Meikle, R D Handbook of the Rubi of Great Britain and Ireland, *review*, 489
  A Flora of the Arctic, *review*, 1347
Meinertzhagen, Colonel R Pirates and Predators, the Piratical and Predatory Habits of Birds, *review* by Sir Landsborough Thomson, 1435
Meinke, Prof W W (Fukai, R, and) Some Activation Analyses of Six Trace Elements in Marine Biological Ashes, 815
Meites, Prof Louis, and Thomas, Prof Henry C Advanced Analytical Chemistry, *review* by W I Stephen, 1525
Mejbaum-Katzenellenbogen, Dr W, and others Regeneration of Protein from Insoluble Protein-Tannin Compounds, 1799
Melanocyte-stimulating Hormone from the Human Pituitary Gland Structure of a (Dr J Ieuan Harris), 167
Melanoma (Cutaneous), in Killifish Hybrids Effect of Thiouracil and Thyroxine on Development and Growth of (Prof A Stolk), 562
Meldola Medal for 1960 (Royal Institute of Chemistry), 1192
Mele, A, and others Influence of Counterion Association on the Configurational Stability of Deoxyribonucleic Acid in Solution, 1482
Meleka, A H, and Dunn, G B Fatigue-Induced After-Effect in Zinc Single Crystals, 896
Melhuish, W H A Fractional Microsublimation Technique, 1933
Mellada, R, and others Peptides with Oxytocic and Pressor Activity obtained from Acidified Rat Serum, 1496
Mellander, Prof O, and others Action of Trypsin on α-Carbethoxy-L-lysyl-L-serylglycine and its O-Phosphorylated Analogue, 187
  O-Phosphorylated and Unphosphorylated Peptide-Substrates suitable for Tryptic Action, 270
Mellon Institute Annual Report for 1958-59, 1109
Mellor, Malcolm Creep Tests on Antarctic Glacier Ice, 717
Mellor Library of the British Ceramic Research Association opened by Frank West, 153
Meloidogyne incognita incognita, the Southern Root Knot Nematode A Virus Disease of (J R Loewenberg, T Sullivan and M L Schuster), 1896
Melon (Water), *Citrullus vulgaris* α-Amino-β-(pyrazolyl-N) Propionic Acid, a New Amino-Acid from (Dr F F Noe and Dr L Fowden), B A 69
Melting (Electron Bombardment Floating-zone), and Allied Electron Bombardment Techniques (Services Electronics Research Laboratory Symposium on), 690
Melting (Glass) The Development of Furnaces for (Dr W M Hampton), 772
Membrane (Human Erythrocyte) Active Transport of Uric Acid through the (Dr Kay Overgaard-Hansen and Dr Ulrik V Lassen), 553
Membrane Filters (Cellulose) Relation of Invasive Capacity to Passage of Lymphocytic Cells through (Dr Emma Shelton and Dr Mary E Rice), 479
Membranes (Cell), in the Anterior Pituitary Gland A Dense Laminar Structure found in Conjunction with (Barbara G Barnes), 651
Membranes (Plant Cell) Maintenance of Semipermeability of, in the Absence of Metabolic Energy Supply (Dr B Ginzburg), 1073
Men Age and the Working Lives of (F Le Gros Clark), 318
  Of Stars and (Dr Harlow Shapley), *review* by Dr W L Sumner, B A 3
Menaker, Prof Michael Endogenous Rhythms of Body Temperature in Hibernating Bats, 1251
Mendeleieff, D I Periodic Law (edited by B M Kedrov), Russian Text, *review* by Prof S I Tomkeieff, 1598
Mendelssohn, Dr K Turning Points in Physics (Probability enters Physics), *review* by G R Noakes, 1090
Menendez, Prof N Polar Front Survey (Hydrography—Temperature and Salinity Conditions along the meridian of Tarifa), 1182
Menon, Dr K P V, and Pandalai, Dr K M The Coconut Palm, *review* by Prof C W Wardlaw, 1760
Menschen und der Wirbeltiere Die gesunden und die erkrankten Zahngewebe des, im Polarisationsmikroscop (Prof W J Schmidt und Dr A Keil), *review* by Prof A I Darling, 218
Mental Health Problems in Old Age (World Health Organization of the United Nations, Technical Report Series No 171), 1844
Menzies, Robert J *Priapulus abyssorum*, New Species, the first Abyssal Priapulid, 1585
Mercer, Derwent M A Current Research on Noise, 414
  Recent Studies of Noise Problems (Physical Acoustics—Accurate Measurements of Aircraft Noise), 415
  New Techniques in the Analysis of Noise and Vibration (Planning Stages of an Analysis), 415
Mercier, R P Fluctuation Phenomena and Stochastic Processes (Theoretical Aspects of Radio-wave Fading), 511
Mercuric Chloride Reaction of, with Plasmalogen (Dr William T Norton), 1144
Mercuripapain Crystals The Unit Cell of (J Drenth and J N Jansonius), 1718
Mercury Influence of Platinum in, on the Mechanism of Electrode Reactions at the Mercury Electrode (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus), 1795
  Reactivation of Vaccinia Virus Inactivated by (Colin Kaplan), 1074
Mercury Electrode Influence of Gold in a, on certain Electrode Processes (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus), B A 56
  Influence of Platinum in Mercury on the Mechanism of Electrode Reactions at the (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus), 1795
Mercury Electrode (Dropping) Reduction of the $FeS_2O_3^+$ Ion at the (F M Page), 1481

Merino Wool Routine Methods for Determining Quality in (P L le Roux) 917
Meristem of Onion Roots Nuclear Deoxyribonucleic Acid Content and Endopolyploidy in the (D Srinivasachar), B A 80
Merlin, an Industrial Research Reactor (Dr T E Allibone), B A 11
  Inauguration of, by H R H the Duke of Edinburgh, 1191
Merriman, Dr A D A Dictionary of Metallurgy, *review* by Dr F C Thompson, 1765
Merton, P A Haemoglobin and Sensory Mechanisms, *review*, 1092
Meryman, Dr Harold T, and Kafig, Emanuel Survival of Spermatozoa following Drying, 470
Mes, the late Prof Margaretha G Influence of Temperature on the Symbiotic Nitrogen Fixation of Legumes, 2032
  Gibberellic Acid and the Chilling Requirements of Peach Seeds, 2034
  Influence of Gibberellic Acid and Photoperiod on the Growth, Flowering, Nodulation and Nitrogen Assimilation of *Vicia villosa*, 2035
Mesenchymal Tissue (Chick) Production of Serum Albumin and of Globulins by, and by HeLa Tumour Tissue in Culture (Y Abdel-Samie Prof E Broda, G Kellner and W Zischka), 361, *erratum*, 943
Meshkov, Prof S Nuclear Forces and the Few-Nucleon Problem (Preliminary Calculations concerning the Structure of ^{6}Li and ^{12}C), 1114
Meson (Tau-) Decay of a, Underground (A M Short), 893
Meta- and *Para*-Isomers of the Xylenes, Cresols and Toluidines by Gas Solid Chromatography Separation of the (M A Hughes, D White and Prof A L Roberts), 1796
Metabolic Activity of Deoxyribonucleic Acid in the Seminal Vesicle Influence of Sexual Stimulation on the (Dr S R Pelc), 1414
Metabolic Changes induced in Mammalian Erythrocytes by Whole-Body X-Irradiation (Prof D A Rappoport and B W Sewell), 846
Metabolic Energy Supply Maintenance of Semipermeability of Plant Cell Membranes in the Absence of (Dr B Ginzburg), 1073
Metabolic Research (Clinical) Enzymic Activities of Human Skeletal Muscle Mitochondria—a Tool in (Dr L Ernster, Dr D Ikkos and Dr R Luft), 1851
Metabolic and Chemical Studies of 'Myleran'—Formation of 3-Hydroxytetrahydrothiophene-1,1-dioxide *in vivo*, and Reactions with Thiols *in vitro* (Dr J J Roberts and Dr G P Warwick), 1288
Metabolism Importance of the Type of, for the Radiosensitivity of Mice (Dr M Pospisil and Dr L Novak), 1814
  Pentose Phosphate (Dr D P Burma), 1368
Metabolism of Cinnamic Acid and Hydroxy-Cinnamic Acids by *Lactobacillus pastorianus* var *quinicus* (Dr G C Whiting and Dr J G Carr), 1427
Metabolism in the Rumen (E F Annison and D Lewis), *review* by Dr D P Cuthbertson, 839
Metabolism (Adrenaline) Activation and Inhibition of (Dr Julius Axelrod and Dr Robert Tomchick), 2027
Metabolism (Carbohydrate), in the Experimental Galactose Cataract (Dr Sidney Lerman), 1406
Metabolism (Carbohydrate), in Hypervitaminosis A (Amal Ray and Prof D P Sadhu), 1323
Metabolism (Endogenous), of a Respiratory-deficient Brewer's Yeast Effect of Oxygen on (V E Chester), 1956
Metabolism (Ethanol) Relation of, to Several Factors in the Rat (Dr F W Kinard, J C Aull, jun, and R E Ulmer), 1721
Metabolism (Extrahepatic), of Ethanol in Man (Dr J A Larsen), 1236
Metabolism (Normal), of Strontium-90 in Rats Attempts to Modify the (Dr V Volf), 1401
Metabolism (Serotonin) A New Inhibitor of (Dr Alfred R Maass and Mary Jane Nimmo), 547
Metabolism (Steroid), In Different Tissues and Subcellular Fractions Distribution of Enzyme Systems responsible for (Virandra B Mahesh and Frank Ulrich), 1147
Metabolism (Thiosulphate), in the Animal Organism (Prof Boleslaw Skarzynski, Tadeusz W Szczepkowski and Miroslawa Weber), 994
Metabolite (Possible Intermediate), of Benzene Hexachloride in Houseflies Pentachlorocyclohexene as a (R G Bridges), 1337
Metabolites Monovalent Cations and the Incorporation of, by Isolated Thymus Nuclei (Dr Theodore R Breitman and Dr George C Webster), 637
Metabolizing (Drug-) Enzymes Stimulatory Effect of Foreign Compounds on Ascorbic Acid Biosynthesis and on (Dr A H Conney and Dr J J Burns), 363
Metal Complexes of Oxine and its Sulphonic Acid Stability of (Prof Adrien Albert and Prof Reino Nasanen), 449
Metal Fatigue (edited by Dr J A Pope), *review* by Dr K M Entwistle, 1438
Metal Ion Indicator Determination of the Interaction of Deoxyribonucleate and Magnesium Ions by means of a (Joseph Shack and Barbara S Bynum), 635
Metal Ions Fungitoxicity of (Dr E Somers), 475
Metal Surfaces (Polished) The Nature of (L E Samuels), 1280
Metallic Liquids A Structural Model for Monatomic Liquids including (Dr Kazuo Furukawa), 1209
Metallogenic Maps (Prof S I Tomkeieff), 1693
Metallurgical Society of the American Institute of Mining, Metallurgical and Petroleum Engineers New series of books entitled Metallurgical Society Conferences, 1362
Metallurgical Thermochemistry (Dr O Kubaschewski and E Ll Evans), *review* by Dr F C Thompson, 1765
Metallurgical and Petroleum Engineers (Mining,) American Institute of (Metallurgical Society of the) New series of books entitled Metallurgical Society Conferences, 1362
Métallurgie, Société Française de Journées Métallurgiques d'Automne (Les Gaz dans les Métaux), 95
Métallurgie, Société Française de (Non-Destructive Testing Group of the Institute of Physics and the) Discussion on the Relationship between Structure and Physical Properties of Materials, 1688
Metallurgists, Institution of Presidential Address, The Education of Technologists (Prof A J Murphy), 514
Metallurgy Advancements in *review* by Dr F C Thompson, 1765
  A Dictionary of (Dr A D Merriman), *review* by Dr F C Thompson, 1765
  Vacuum—Lectures presented during the Course sponsored by the Department of Metallurgical Engineering in co-operation with the Office of Special Service to Business and Industry, New York University, 1957, *review* by Dr F C Thompson, 1765
Metallurgy of Magnesium, *review* by Dr J W Martin, 486
Metallurgy (The Physical), of Magnesium and its Alloys (Prof G V Raynor), *review* by Dr J W Martin, 486
Metals Spectrographically Pure (Prof W Hume-Rothery), 1794
  A Theory of the Abrasion of Solids such as (J Goddard, H J Harker and H Wilman), 333
Metals' 'Joining of (Third Conference at the University of Birmingham—The Electric Arc in Welding), 1030
Metals, Institute of Election of Officers, 1688
  Monograph and Report Series No 23, Vacancies and other Point Defects in Metals and Alloys—a Symposium held at the Atomic Energy Research Establishment, 1957, *review* by Dr F C Thompson, 1765
Metals (Coinage), Cu, Ag, Au Electron Spin Resonance and Divalency of some Dithiocarbamates of the (Tore Vanngard and Stig Åkerstrom), 183
Metals (Rare Earth) Production of all the (Johnson, Matthey and Co, Ltd), 683
Metals (Trace), in Cheese Fat Oxidation and (Tallowy Discoloration in Cheddar Cheese), (F Bishop), 1295
Metals and Alloys A Handbook of Lattice Spacings and Structures of (Dr W B Pearson), *review* by Dr J A Catterall, 841
  Martensitic Transformations in (Academician G V Kurdjumov), 1450
  Vacancies and other Point Defects in—a Symposium organized by the Institute of Metals, 1957 (Monograph and Report Series, No 23), *review* by Dr F C Thompson, 1765
Metanephros (Foetal), and Foetal Liver Relative Rates of Exchange of Potassium-42 by the (Dr J G Bearn and Dr F T C Harris), 1959
Metastases (Rous I Sarcoma) Inhibition of, by a Copper-Catalyst Blocking Agent (Dr B M Jones), 1963
Métaux Les Gaz dans les (Société Française de Métallurgie Journées Métallurgiques d'Automne), 95
Metcalf, W G (Worthington, L V, and) Polar Front Survey (Hydrography—Salinity/Potential Temperature Relationship in the North Atlantic Deep Water), 1182
Metcalfe, R L (edited by) Advances in Pest Control Research, Vol 2, *review* by F C Bawden, 1258
Meteorite ? A Fossil (A I Shulzhenko) 1026
Meteorite 'Carbo' (Iron) Calculation of a 'Cosmic Ray Age' for the (Dr Royal R Marshall), 117
Meteorological Data, 942
Meteorological Office (Air Ministry) Geophysical Memoirs No 100, World Distribution of Atmospheric Water Vapour Pressure (G A Tunnell), B A 15
Meteorological Organization, World Technical Note No 25, Design of Hydrological Networks (Max A Kohler), Technical Note No 26, Techniques for Surveying Surface-Water Resources (Prof Ray K Linsley), 96, *erratum*, 684
  Technical Note No 27, Use of Ground-Based Radar in Meteorology (excluding Upper-Wind Measurements), 942
Meteorological Society, Royal Election of Officers for 1959-60, 1108
Meteorology Use of Ground-Based Radar in (excluding Upper-Wind Measurements), (World Meteorological Organization, Technical Note No 27), 942
Meteorology (Equatorial) Value of Contour Analysis in (D H Johnson and Dr H T Morth), 1372
Methacrylate (γ-Irradiated Polymethyl), and Polymethacrylic Acid Electron Paramagnetic Resonance at 4 2° K of (Dr Derick W Ovenall), 181
Methaemoglobin Reduction through Cytochrome B_5 (Nicola Petragnani, Otilia C Nogueira and Isaias Raw), 1651
Methane Sulphonate (Ethyl) Mutation of Bacteria at High Levels of Survival by (Anthony Loveless and Sheila Howarth), 1780
Methanol Effect of Gamma-Radiation on the Synthesis of, over Zinc Oxide (T I Barry and R Roberts), 1061
Method Clinical Biochemical (Dr A L Tarnoky), *review* by Dr D S H W Nicol, 576
Method enabling Animals to survive Freezing at an Extremely Low Temperature Prefreezing as a (Eizo Asahina), 1003
Method for Determining Carbon-14 by Combustion using Calcium Carbonate (E C S Little), 900
Method for Distinguishing Bovine Type Tubercle Bacilli from other *Mycobacteria* Nicotinamidase in *Mycobacteria*—a (Dr Kiyoshi Konno, Dr Hideo Nagayama and Dr Sutemi Oka), 1743
Method for Distinguishing between α- and β-Glycosides by the use of Plant Haemagglutinins (Lectins), (Dr O Makela), 111
Method of Increasing the Phosphorus Content of Forages (Prof R Ferrando, S Metivier and R Gervy), 76
Method for *in vitro* Investigation of the Colloid-storing Function of Histiocytes (Prof N Jancso, Aurelia Jancso-Gabor and J Balassy), 1070
Method for Purification of Protein-bound Peptides as exemplified by Oxytocin and Vasopressin Gel Filtration as a (E B Lindner, Dr A Elmqvist and Dr J Porath), 1565
Method for the Quantitative Study of the Surface Precipitation Reaction (Francis T Ashton), 1735
Method (Calorimetric) Ultrasonic Absorption in Acetic Acid at 450 kc /s by the (S Parathasarathy and V N Bindal), 631
Method (Capacitance), for following Vinyl Polymerizations Initiated by γ-Rays (G J K Acres and F L Dalton), 335
Method (Micro-), for the Polarographic Determination of Serine (J Ladik and Dr I Szekacs), 188
Method (Modified Rotating-Sector), of Measuring Kinetic Chain Lifetimes (Dr W I Bengough, S A McIntosh and R A M Thomson), 266
Method (New), for Studying the Functioning of the Lungs (Helge Colldahl, T Alvager and J Uhler), 372
Method (New), for Working up Processing Mixtures containing Anhydrous Aluminium Chloride (Dr T Széll and A Furka), 117, *erratum*, 595
Method (New Two-Dimensional Paper Chromatographic), applied to the Separation of Amino-Acids (C S Knight), 1486
Method (Paper-Chromatographic), for the Determination of Suitable Buffer Systems for Countercurrent Distribution (Andrzej Waksmundzki and Edward Soczewinski), 977
Method (Powder), in X-Ray Crystallography (Prof Leonid V Azaroff and Prof Martin J Buerger) *review* by Prof H Lipson, 1599

Method (Quick), for Extracting Plant Embryos from certain Types of Seed (M D Gwynne), 1588
Method (Rapid), for Studying Tumour Blood Supply using Systemic Dyes (Dr R J Goldacre and Dr B Sylvén), 63
Method (Rapid and Sensitive), for the Determination of Xanthine Oxidase Activity using the Oxygen Electrode (Metry Bacila and Dr Gilberto G Villela), 1394
Method (Scientific) The Discipline of the, 295
Method (Simplified), for the Culture of *Blatella germanica* under Aseptic Conditions (R B Clayton), 1166
Method (Soil Block Test), for Timber Limitations Imposed by some Water-borne Preservatives on the (A J McQuire), 1430
Method (Specific and Sensitive Assay), for Vasopressin and Oxytocin using Glass-Paper Chromatography (Akira Arimura and Prof Joseph F Dingman), 1874
Methods Micro- and Semi-microchemical (Norwood Technical College Course of lectures and practical work on), 1845
  Statistical, *review* by W J Langford, 1523
  X-Ray Powder, *review* by Prof H Lipson, 1599
Methods of Oceanography Apparatus and (Dr H Barnes), Part I, Chemical, *review* by F A J Armstrong, 299
Methods of the Sciences Origins and, *review* by Prof A V Hill, 4
  Studies in the History and (Prof Arthur David Ritchie), *review* by Prof A V Hill, 4
Methods (Chromatographic) Separation of Polyvinyl Chloride and Polyvinyl Acetate by (W J Langford and D J Vaughan), 116
Methods (Colorimetric), of Analysis, including Photometric Methods (Dr Foster Dee Snell and Dr Cornelia T Snell, assisted by Dr Chester Arthur Snell), Vol 2A, *review* by J King, 1522
Methods (Immunological) Assay of Plasma Insulin in Human Subjects by (Dr Rosalyn S Yalow and Dr Solomon A Berson), 1648
Methods (Mathematical), of Operations Research (Thomas L Saaty), *review* by Prof L S Goddard, 1763
Methods (Mechanical Impedance), for Mechanical Vibrations—Colloquium presented at the Annual Meeting of the American Society of Mechanical Engineers, 1958 (edited by R Plunkett), *review* by Prof R E D Bishop, 1764
Methods (Photometric) Colorimetric Methods of Analysis, including (Dr Foster Dee Snell and Dr Cornelia T Snell, assisted by Dr Chester Arthur Snell), Vol 2A, *review* by J King, 1522
Methods (Radiofrequency) Molecular and Atomic Motions in Liquids and Solids by (Colloque AMPERE and the Radiofrequency Spectroscopy Group Joint Discussion on), 157
Methods (Routine), for Determining Quality in Merino Wool (P L le Roux), 917
Methods and Techniques . Blood Group, *review* by Dr R A Zeitlin, 130
Methoxamine Radioprotective Action of (A D Smith, Dr M J Ashwood-Smith and Doreen Lowman), 1729
Methoxides (Volatile), of Aluminium and Zirconium (Dr D C Bradley and Dr M M Faktor), 55
7-Methoxy-8-Aminomethylchromones and Flavones (N-Substituted)—New Brain-Stem Stimulants (P Da Re, B Verlicchi, Dr I Setnikar, W Murmann and M J Magistretti), 362
6-Methoxybenzoxazolinone (Antifungal Substance) Isolation of the, from Field Corn (*Zea mays* L) in Canada (N J Whitney and C G Mortimore), 1320
Methuen, Lord The Country House and the Museum, 598
Methyl 2-Acetamido-2-Deoxy-α-D-Glucopyranoside *N*-Methylation of (Dr S A Barker, Prof M Stacey and Dr D J Tipper), 1718
N-Methyl Carbon of Monoethylaminoazobenzene Incorporation of, into Polar Dyes (Prof Hiroshi Terayama, Prof Morizo Ishidate and Akira Hanaki), 1460
Methyl Esters (Long-chain Fatty Acid) Gas Chromatographic Separation of, on Polyvinyl Acetate (Irwin Hornstein, L E Elliott and P F Crowe), 1710
O-Methyl Ethers (Isomeric), of Ethyl di-(4-hydroxycoumarinyl-3)-Acetate (the Anti-coagulant Drug Pelentane or Thromexane), (Dr Eduard Knobloch), 1568
4-0-Methyl Glucoronic Acid in *Rhizobium* Gums Occurrence of (Beverley A Humphrey), 1802
Methyl Linoleate Hydroperoxide (*trans-trans*) Preparation of Crystalline (A Banks, S Fazakerley, J N Keay and J G M Smith), 816
N-Methylation of Methyl 2-Acetamido-2-Deoxy-α-D-Glucopyranoside (Dr S A Barker, Prof M Stacey and Dr D J Tipper), 1718
24-Methylene-cholesterol Isolation of, from Honey Bees (*Apis mellifica* L), (Dr M Barbier, Prof T Reichstein, Dr O Schindler and Prof E Lederer), 732
ε-N-Methyl-lysine in Bacterial Flagellar Protein (R P Ambler and M W Rees), 56
Methylthiouracil or Thyroidectomy Effects of, on Activation of Pituitary Acid Phosphatases *in vitro* by Whole Hypothalamic Extract (Dr V Schreiber and Dr V Kmentova), 728
Metivier, S , and others A Method of Increasing the Phosphorus Content of Forages, 76
Metropolitan-Vickers Electrical Co , Ltd Nuclear-Metals Laboratory, 234
  Wall-chart of the Metro-Vickers Type *EM6* Electron Microscope, 237
  The Instrument and Meter, Scientific Apparatus and X-Ray Departments of, to combine with Sunvic Controls, Ltd , to form the Instrumentation Division of Associated Electrical Industries, Ltd , 1535
Metropolis, Dr N C At the first Conference of the British Computer Society (Very Fast Computers), 945
DL-[2-^{14}C] Mevalonic Acid Lactone Incorporation of, into Polyisoprene (R G O Kekwick, B L Archer, D Barnard, G M C Higgins, G P McSweeney and C G Moore), 268, *erratum*, 772
Mewissen, Dr D J Dose–Response Relationship in Radiation Leukaemia, 1670
Meyer, Anne L (Lasslo, Dr Andrew, and) Effect of Chlorpromazine upon Isolated *d*-Amino-Acid Oxidase Systems, 1922
Meyer, J Moisissures du Sol et des Litières de la Région de Yangambi (Institut National pour l'Etude Agronomique du Congo Belge, Publications, Série Scientifique No 75), 236
Meyer, J , and Pampfer, E Nitrogen Content of Rain Water collected in the Humid Central Congo Basin, 717
Meyer, Dr R , and others Separation of Fast-Moving γ-Globulins by Starch-Gel Electrophoresis, 1800
Meyer-Arendt, Prof Jurgen R Deviation of Zone Lenses produced by Polarization, 811
Mice Antibody Status of, and Response of their Litters to Parotid Tumour Virus (Polyoma Virus), (Lloyd W Law, Clyde J Dawe, Wallace P Rowe and Janet W Hartley), 1420
  An Experimental Enterococcal Pyelonephritis in (Dr Arvid L Erlandson, jun , Dr Leola A Gagliardi and Dr Myron W Fisher), 561
  Fate of Injected Dextran Labelled with Tritium in (A Hanngren, E Hansson, S Ullberg and Prof B Åberg), 373
  Importance of the Type of Metabolism for the Radiosensitivity of (Dr M Pospisil and Dr L Novak), 1814
  Immunization with Biologically Active Fractions of Deoxyribonucleic Acid and Subsequent Specific Infection of (Dr M Kohoutova), 1965
  Opsonins as Determinants of Survival in Intraperitoneal Infections of (Dr C R Jenkin and Prof D Rowley), 474
  Production of Odd-Numbered Carbon Fatty Acids from Propionate by (Prof S B Tove), 1647
  Prophylactic Effects of Amine Oxides in Radiation Injury in (Dr Thomas J Haley, Dr Anna M Flesher and Dr Nathan Komesu), 198
  Pure Culture of the Pathogenic Agent of Tyzzer's Disease of (Dr K Kanazawa and A Imai), 1810
  Splenic Siderosis in, treated with Dithiourethane (Prof P N Cowen), 366
  Thiamine-sparing Action of Sorbitol in Rats and (Dr T B Morgan and Prof John Yudkin), 909
  Tumourigenesis in Ovaries of, transplanted to the Liver, Kidney and Adjacent Tissues (Dr Mary J Guthrie), 916
Mice infected with Rabbit-pox Virus Antiviral Chemotherapeutic Activity of Isatin and β-thiosemicarbazone in (D J Bauer and F W Sheffield), 1496
Mice (*AKR*) Chromosome Complement of Spontaneous Leukaemia in (H F Stich, R Wakonig and Dr A A Axelrad), 998
Mice (Adult) Tolerance to Skin Homografts of, after Parabiosis (Dr B A Rubin), 205
Mice (Dehydrated and Fasted) Subcutaneous Absorption of Urethane in (Eigill Hvidberg and Jens Schou), 646
Mice (Dystrophic) Prolonged Survival of, treated with 17α-Ethyl-19-Nortestosterone (Dr Robert M Dowben), 1966
Mice (Lethally Irradiated) Interstrain Ovarian Transplantation in, after Bone Marrow Therapy (Prof W St Amand and L H Smith), 1503
Mice (Lethally X-Irradiated) Abrogation by Injected Mouse Blood of Protective Effect of Foreign Bone Marrow in (L J Cole and R M Garver), 1815
Mice (Newborn Rats and) An Improved Technique for Intravenous Injection of (N F Anderson, E J Delorme, Prof M F A Woodruff and D C Simpson), 1952
Mice (Normal and Adrenalectomized) Effect of Diet on the Blood Sugar and Liver Glycogen Level of (B P Block and Dr G S Cox), 721
Mice (Obese-Hyperglycaemic) Increased Circulating Insulin-like Activity in (Jean Christophe, Yves Dagenais and Jean Mayer), 61
Mice (Parabiotic) Skin Homografts in (Anna Skowron-Cendrzak and Barbara Konieczna-Marczynska), 1590
Mice (Thymectomized), Inoculated with Leukaemic Filtrate Fate of Subcutaneous Thymus Grafts in (J F A P Miller), 1809
Michaelis, M (Eaton, S E , and) Radiation in Industry, 506
Michalska, Prof K Interaction of Streptomycin and Dihydrostreptomycin with Apo- and Co-dehydrogenases, 987
Micheel, F Coal Science (Chemical Reactions of Coal—Chromatographic Separation of Oxidation Products of Coal), 413
Micro- and Semi-microchemical Methods (Norwood Technical College Course of lectures and practical work on), 1845
Microanalysis (X-Ray) : X-Ray Microscopy and (International Symposium on), 860
Microbacterium lacticum 8181 An Absolute Requirement for 'Iron Transport Factors' by (Dr D Hendlin and Dr A L Demain), 1894
Microbes on the Move, *review* by Dr N Blakebrough, 1598
Microbial Degradation of Rutin (Dr S Hattori and I Noguchi), 1145
Microbial Population Effect of the Level of, on Isotopically Exchangeable Phosphate in Soil (Dr P Newbould and Dr R L Lucas), 1155
Microbiological Filaments in Soils Occurrence of (Roy D Bond), 744
Microbiological Research, 680
Microbiological Transformation of a Cardiac Aglycone (Hayao Nawa, Masao Uchibayashi, Takaaki Kamiya, Togo Yamano, Hideo Arai and Matazo Abe), 469
Microbiology at Sheffield, 234
Microbiology, Institute of Perspectives in Biology—a Symposium (edited by Morris Pollard), *review* by N W Pirie, 920
Microbiology (General), Society of Eighth Symposium—The Strategy of Chemotherapy (edited by S T Cowan and E Rowatt), *review* by Prof H Berry, 133
  Ninth Symposium on Virus Growth and Variation, London, 1959 (edited by A Isaacs and B W Lacey), *review* by N W Pirie, 920
Microbiology (Industrial) Progress in (edited by Dr D J D Hockenhull) Vol 1, *review* by Dr N Blakebrough, 1598
Microcard Adapter for 'Dagmar' Microfilm Reader (Trew Microfilming Ltd), 941
Micrococcus lysodeikticus Cell-Wall Mucopeptides of *Staphylococcus aureus* and (H J Rogers and H R Perkins), 520
Microcosm to Macrocosm, *review* by G R Noakes, 214
Micro-Electrodes (Glass), for Measuring Intracellular Activities of Sodium and Potassium (Dr J A M Hinke), 1257
Microfilm Reader ('Dagmar') Microcard Adapter for (Trew Microfilming Ltd), 941
Micromethod for the Polarographic Determination of Serine (J Ladik and Dr I Szekacs), 188
Micron (Sub-) Multiple Fibres High Resolution Fibre Optics using (Dr N S Kapany), 881
Micronesians High Prevalence of High-Level β-Amino-*iso*butyric Acid Excretors in (Dr B S Blumberg and Dr S M Gartler), 1990
Micro-organisms Biology and Biochemistry of (Indian Institute of Science Symposium on), 1367
  Culture of Algae and other, in Deuterium Oxide (Henry L Crespi, Sylvia M Archer and Joseph J Katz), 729
  Tocopherols in (J Green, S A Price and L Gare), 1339

Micro-organisms in Suspension Effects of the Energy of Strong Pulses of Ionic Current on (B S Gossling), 1881
Micro-organisms (Soil) Factors in Forest-Tree Litter Extracts affecting the Growth of (Dr Roger Knowles and Edward Laishley), 1169
Microphone to Ear From (G Slot), second edition, *review* by Prof Colin Cherry, 841
Micropulsation Measurements in California and Alaska (W H Campbell and B Nebel), 628
Microscope The Practical Use of the (George Herbert Needham), *review* by Dr S Bradbury, 1174
Microscope (Electron) Wall-chart of the Metro-Vickers *EM6* (Metropolitan-Vickers Electrical Co , Ltd), 237
Microscope (An Image-Splitting), for Accurate Measurement (J Dyson), 1561
Microscopes and Photomicrography, *review* by Dr S Bradbury, 1174
Microscopic (Electron-) Structure of the Sensory Hairs in the Cristae of the Elasmobranch *Raja clavata* A Functional Interpretation of the, in Terms of Directional Sensitivity (Prof O Lowenstein and J Wersäll), 1807
Microscopic (Electron-) Study of Spores of Morphological Variants of *Streptomyces erythreus* Strains (L Dolezilova, Z Vanek and O Kralík), 1888
Microscopical Objects Recording the Positions of (Dr J R Baker), 34
Microscopical (Electron) Structure of the Wall of Small Blood Vessels in Human Multiform Glioblastoma (Dr S H M Nystrom), 65
Microscopy of Cellulosic Fibres A Special Case of the Superposition of Crystal Plates between Crossed Polars and its Bearing on the (Dr N H Hartshorne), 179
Microscopy (Electron) An Embedding Resin Miscible with Water for (Dr I R Gibbons), 375
  The Shape of Protein Molecules suggested by (Dr R C Valentine), 1838
Microscopy (Electron), of Autoradiographed Radioactive Particles (L A George, II, and G S Vogt), 1474
Microscopy (Electron), of Viruses Recent Work on the (Dr Kenneth M Smith), 1440
Microscopy (Electron Emission) Field Effects on Chemisorbed Films in (R J Hill and P W M Jacobs), 895
Microscopy (X-Ray), and X-Ray Microanalysis International Symposium on, 860
Microscopy and Photomicrography Applied (H M Malies), *review* by Dr S Bradbury, 1174
Microsecond Pulse Conditions Conduction Currents in Liquid *n*-Hexane under (A Harry Sharbaugh and P Keith Watson), 2006
Microsporangia of *Leptomeria billardierii* R Br Occurrence of Embryo Sac-like Structures in the (Dr Manasi Ram), 914
Micro-sublimation Technique A Fractional (W H Melhuish), 1933
Microwave Harmonic Generator A New (Dr K D Froome), 808
Micro-Windows (Interfacial) Wear Observations through (Robert H Savage), 45
Middle East Economic Developments in the, 1957-58 (Supplement to World Economic Survey, 1958), (United Nations), 1280
Middlebrook, Prof Transistors and Associated Semiconductor Devices, 693
Middlesex Hospital Medical School, London Appointment of R E M Thompson as reader in bacteriology, 322
  Appointment of Dr F Hobbiger to the University of London readership in pharmacology, 595
  Appointment of J W Stewart to the University of London readership in haematology, 595
Middleton (Sir Thomas) Memorial Lecture (Dr E B Worthington), 1535
Midgley, Dr H G Clay Minerals (Occurrence of Sepiolite in Cornwall), 780
Midlands Natural History in the, 1024
Midttun, L Polar Front Survey (Hydrography—Norwegian work in the Barents Sea), 1181 , (Biology—Echo-Surveys in the Barents Sea), 1184
Midwinter, G G (Hatherton, Dr T , and) Diurnal Variation of Aurora and Geomagnetic Disturbance at New Zealand Antartic Stations, 889
Mieszkis, K W , and others Friction in Textiles, *review*, 1765
Migicovsky, Dr B B Removal of Strontium and Caesium from Milk, 374
Migrant (Trans-Equatorial), the Short-tailed Shearwater *Puffinus tenuirostris* Experimental Demonstration of an Internal Rhythm of Reproduction in a (Dr A J Marshall and Dr D L Serventy), 1704
Migrating Elvers (*Anguilla vulgaris* Turt) Discrimination between Ebb and Flood Tide in, by means of Olfactory Perception (F Creutzberg), 1961
Migration Eel (Dr J W Jones), 1281 , (Dr Denys W Tucker), 1281
Migration (Downstream) Retinal Responses of Pink Salmon associated with its (Dr M A Ali and Prof W S Hoar), 106
Migratory Locust Maternal Control of Ovariole Number in the Progeny of the (F O Albrecht, M Verdier and R E Blackith), 103
Miki, T , and others Chemistry and Pharmacology of 16-Acetyl Digitalinum Verum, 1414
Mild Steel Surface-Hardened by Carbo-Nitriding Identification of the High-Temperature Constituent in (M A H Howes, G T F Jay, K Sachs and D Wilkinson), 1312
Miledi, Dr R , and others Dissociation of the 'Surface Membrane Complex' in Atrophic Muscle Fibres, 1507
Miles, Dr Charles P Sex Chromatin in Cultured Human Tissues, 477
Miles, Dr G L (Martin, Dr F S , and) Chemical Processing of Nuclear Fuels, *review* by Dr J E Littlewood, 1346
Miles, Prof H W Orchard Science, *review*, 487
Miles, Surg Comdr S Heating and Ventilation (Problem of the Confinement of a Crew in Complete Isolation while they Worked, Played, Ate and Slept encompassed by the Sea), 1988
Milk Current Trends of Strontium-90, Strontium-89 and Caesium-137 Levels in (W Anderson, L K Burton and J O Crookall), 89
  Implications of Restricting Cows to a Clover-free Diet in order to Reduce the Strontium Content of (Dr David Purves), 1408
  Potassium and Lactose in, in relation to the Physiology of Milk Secretion (Dr J A F Rook and Marian Wood), 647
  Removal of Strontium and Caesium from (Dr B B Migicovsky), 374
Milk from Cows treated with Penicillin Lowered Bactericidal Efficiency of Hydrogen Peroxide on (J Babad, D L Boros and F Baier), 292
Milk (Ewes') Effect of Cobaltic Oxide Pellets on the Vitamin B_{12} Content of (L I Hart and E D Andrews), 1242
Milk Secretion Potassium and Lactose in Milk in relation to the Physiology of (Dr J A F Rook and Marian Wood), 647
Milledge, Dr H Judith and others Transformation of Cubic Boron Nitride to a Graphitic Form of Hexagonal Boron Nitride, 715
Milledge, Dr H Judith (Lonsdale, Dame Kathleen, and) An X-Ray Study of Rigid-Body and Internal Vibrations of Organic Molecules, 1545
Millen, Dr D J Title of reader in chemistry in the University of London (at University College) conferred on, 1451
Miller, Donald S , and others The Geological Time-Scale, B A 62
Miller, F Justin Carbon Dioxide in Water, in Wine, in Beer and in other Beverages, *review* by Dr A H Cook, 302
Miller, J F A P Fate of Subcutaneous Thymus Grafts in Thymectomized Mice Inoculated with Leukaemic Filtrate, 1809
Miller, Dr Kent D Rivanol, Resin and the Isolation of Thrombins, 450
Miller, Lawrence P Plant Growth Regulation, 599
Miller, P J *Acanthocottus lilljeborgi* (Collett) in British Seas, 1162
Millerd, A , and others Oxidation of Krebs Cycle Acids by Apple Tissue, 506
Millington, G *Obituary* of T L Eckersley, 149
Millman, Dr A P Appointed to the University of London readership in mining geology at the Imperial College of Science and Technology, 595
Mills, Dr A A Biological Properties of Coal and Coal Extracts, 1885
Mills, J R E (Butler, P M , and) A Contribution to the Odontology of *Oreopithecus*, 682
Milne, Dr A A Controversial Equation in Population Ecology, 1582
Milne, J G C , and others Ionization Phenomena in Gases (Influence of Gas Purity, Tube Geometry and Method of Calculation on the Determination of Ionization Coefficients in Hydrogen and the Inert Gases), 1354
Milner, D R The Electric Arc in Welding, 1030
Milner, G W C Nuclear Energy and Analysis, *review*, 1524
Milone, Ferdinando Carta della Utilizzazione del Suolo, Sheets 19 and 20, Calabria , Sheets 21, 22 and 23, Sicily (Consiglio Nazionale della Ricerche, Napoli), 27
Milwright, A L P At the Annual General Meeting and Conference of the Mathematical Association (The Southampton Port Operation and Information Service), 32
Mimosa pudica Changes in the Lacunal Parenchyma of, in Diurnal and Nocturnal Conditions (Hideo Toriyama), 737
Mineral Fissures Alpine (International Mineralogical Association Symposium on), 1909
Mineral Oil Survival of Grasshopper Eggs kept for Long Periods in (Prof Eleanor H Slifer), 1424
Mineral Uptake and Retention in Cotton-Grass (*Eriophorum vaginatum* L), (Gordon T Goodman and Donald F Perkins), 467, *erratum*, 1845
Mineralogical Aspects of Soil Science (Welsh Soils Discussion Group Discussion on), 156
Mineralogical Association, International First General Meeting (Prof Robert L Parker), 1909
  Symposium on Alpine Mineral Fissures, 1909
  Symposium on Twinning of Crystals, 1910
Mineralogical Society (Clay Minerals Group) Discussion on Clay Minerals, 780
Mineralogical Study on Clays of Japan (Dr Toshio Sudo), *review* by Dr. D M C MacEwan, 1439
Mineralogy (Systematic), of Uranium and Thorium (Prof Clifford Frondel), *review* by Prof C F Davidson, 576
Mineralogy and Geology of Radioactive Raw Materials (Prof E Wm Heinrich), *review* by Prof C F Davidson, 1262
Minerals Clay (Clay Minerals Group of the Mineralogical Society Discussion on), 779
  Clay (X-Ray Analysis Group of the Institute of Physics Discussion on), 780
Minerals (Carbonate), in Hydrated Portland Cement (W F Cole and B Kroone), B A 57
Mines Aerial Photographs of Quarries and (Exhibition at the Geological Museum, London), 855
  Rock Pressure in (E de St Q Isaacson), *review* by J K L Graham, 1349
Mines (Safety in) Research Establishment Thirty-sixth Annual Report (1957), (Ministry of Power), 154
Mining Engineers, Institution of Election of R G Baker as president for 1960-61, 1845
  Election of A Hellemans and Dr J Taylor as honorary members, 1845
  Douglas Hay Medal awarded to A E Crook, 1845
  Maskell Peace Scholarship for 1959 awarded to P Hutchinson, 1845
Mining, Metallurgical and Petroleum Engineers, American Institute of (Metallurgical Society of the) New series of books entitled Metallurgical Society Conferences, 1362
Minister for Science The First (Rt Hon Viscount Hailsham), 1263
Minnaert, M G J Elected an Honorary Member of the American Academy of Arts and Sciences, 410
Mintz, Beatrice (edited by) Environmental Influences on Prenatal Development (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Miranda, F Origin and Dispersal of Flowering Plants (Mountainous and Low-lying Floras of Tropical America), 1201
Mirrors Museums as—their Potentialities and Limitations (International Council of Museums Conference on), 504
Mishina, Akira, and Nikuni, Ziro Physical and Chromatographical Observations of γ-Irradiated Potato Starch Granules, 1867
Mitchel, N C Appointed lecturer in geography at Queen's University, Belfast, 322
Mitchell, Dr A R Appointed senior lecturer in mathematics at St Salvator's College, St Andrews, 684
Mitchell, B D , and Mackenzie, Dr R C Clay Minerals (A Controlled-Atmosphere Differential Thermal Analysis Apparatus), 780
Mitchell, Dr H K Cytoplasmic Inheritance (Biochemical and Genetic Aspects of Poky *Neurospora*), 1012
Mitchell, Dr R L Promoted to Deputy Chief Scientific Officer in the Scientific Civil Service, 859 , work of, 859
Mitchison, N A Delayed Hypersensitivity (Possible Resemblances between Delayed Hypersensitivity and the Homograft Reaction), 1029

Mites, or the Acari (T E Hughes), *review* by G O Evans, 1677
Mitochondria of the Human Heart Histochemical Localization of Oxidase Activity in the (Dr M S Burstone), 476
Mitochondria from Tomatoes Production of Ethylene by (Prof Mary S Spencer), 1231
Mitochondria (Human Skeletal Muscle) Enzymic Activities of—a Tool in Clinical Metabolic Research (Dr L Ernster, Dr D Ikkos and Dr R Luft), 1851
Mitochondria (Isolated) Effect of Reduced Diphosphopyridine Nucleotide on the Swelling of (Dr G Di Sabato), *erratum*, 95
Mitochondria (Isolated Rat Liver) Protein Biosynthesis and Oxidative Phosphorylation in (P J Reis, J L Coote and T S Work), 165
Mitochondria (Liver) Functional Organization of the Respiratory Chain in (Dr Tokuji Kimura and Dr Thomas P Singer), 791
Mitochondria (Mung Bean) Glutamic Dehydrogenase of (Dr D H Bone), 990
Mitochondria (Nadi-Positive), (*Gamma* Particles), and Development in the Water Fungi *Blastocladiella* and *Allomyces* (Prof Edward C Cantino and Gilbert Turian), 1889
Mitochondria (Rat Liver) A Cardiolipin-like Compound in (G S Getz and W Bartley), 1229
  Formation of Noradrenaline from Adrenaline by (Dr Kunio Yagi and Dr Toshiharu Nagatsu), 1316
  Pantothenic Acid Deficiency and Ubiquinone Levels in (A S Aiyar, G A Sulebele, D V Rege and A Sreenivasan) 1867
Mitochondrial Enzyme Systems Effect of some Neuromuscular Blocking Agents on (Dr J H Koch and Dr C H Gallagher), 1039
Mitochondrial Oxidative Phosphorylations in Intact Ascites Tumour Cells Efficiency of the (Dr P Emmelot and C J Bos), 2024
Mitochondrial Pyridine Nucleotide Fluorescence Measurements of, in Aerobiosis and Anaerobiosis (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Prof Britton Chance and Dr Bo Thorell), 931
Mitochondrial Structure Cytochemical Study of (Prof C H Chopra), 656
Mitomycin C Induction of Phage Formation in the Lysogenic *Escherichia coli K*-12 by (Dr Nozomu Otsuji Dr Mutsuo Sekiguchi, Dr Teiji Iijima and Dr Yasuyuki Takagi), 1079
Mitosis (Unimpaired), in Cells with Modified Deoxyribonucleic Acid (Rolla B Hill, jun , Klaus G Bensch and Donald W King), 1429
Mitsui, Tetsuo, and others Plant Growth Activities of 5- and 8-Halogeno-Dihydro- and Tetrahydro-1-naphthoic Acids, 1415
Mitsuki, Chikara, and Kita, Masayoshi Transition of Calcium Sulphate Hemihydrate to Insoluble Anhydrite, 1481
Mixed Solvents Action of, on Wool (J C Atkinson, A Filson and Prof J B Speakman), 444
Mixture of Hydrogen Peroxide and Ferric Salts Oxidation of Ethyl Alcohol by a (Dr Mordechai L Kremer), 720
Mixtures (Binary Gas) Sensitivity of Catharometers in Gas Chromatography and the Thermal Conductivity of (A B Littlewood), 1631
Mixtures (Liquid) Liquids and (Dr J S Rowlinson), *review* by Prof H S Longuet-Higgins, 1901
Mixtures (Processing) containing Anhydrous Aluminium Chloride A New Method for Working up (Dr T Széll, and A Furka), 117, *erratum*, 595
Miyake, T Fertility Factor in *Salmonella typhimurium*, 657
Mizgalski, Dr Wizold, and Zygmunt, Irena Effect of Ultrasound on the Protein of Human Serum Denatured with Tannin, 1486
Mobile Liquids Proton Resonance Relaxation Times in (Dr J G Powles and D Cutler), 1123
Mobility (Electrophoretic), and Colourability of Substituted Human Serum Proteins Modifications in Immunological Behaviour, (M Steinbuch, Dr J M Fine and A Battistini), 1571
Mode of Action Plant-Growth Substances and the Copper Chelating Theory of their (Dr C H Fawcett), 796
Mode of Egg Laying in Tingidae (Hemiptera), (T S Thontadarya and G P Channa Basavanna), 289
Model of the Solar Corona Kellogg and Ney's (Dr D E Blackwell and Dr D W Dewhirst), 1120 , (Prof Edward P Ney and Prof Paul J Kellogg), 1122
Model (A Mathematical), for Perception and a Theoretical Confusion Function (M Hammerton), 1668
Model (A Structural), for Monatomic Liquids including Metallic Liquids (Dr Kazuo Furukawa), 1209
Models in Fire Research The Use of (Committee on Fire Research and the Fire Research Conference of the Division of Engineering and Industrial Research of the United States National Academy of Sciences—National Research Council Symposium on), 772
Models of Tobacco Mosaic Virus and the Size of the Virus Particle Rotational Friction Coefficients of (Dr A J Haltner and Dr B H Zimm), 265
Models (Working), of Marine Engines Exhibition of (Liverpool Public Museums), 1534
Modern Abstract Algebra Selections from (Richard V Andree), *review* by Prof T A A Broadbent, 301
Modern Democracy The Development of Public Services in a, 1087
  General Education in a, 1171
Modern Inorganic Chemistry, *review* by Dr D W A Sharp, 1756
Modern Network Theory in Electrical Engineering (University of Birmingham Conference on), 1691
Modern Physics Guide to, *review* by Prof H Lipson and S G Lipson, 298
  Principles of (Prof Robert B Leighton), *review* by Dr E Stanley, 1438
Modern Science Darwin without, *review* by Sir Gavin de Beer, 385
Modern Theory of the Integral, *review*, 574
Modi, Dr V V , and Patwa, D K Biosynthesis of Carotenes in Carrot Extracts, 983
Modifications in Immunological Behaviour, Electrophoretic Mobility and Colourability of Substituted Human Serum Proteins (M Steinbuch, Dr J M Fine and A Battistini), 1571
Modified Deoxyribonucleic Acid Unimpaired Mitosis in Cells with (Rolla B Hill, jun , Klaus G Bensch and Donald W King), 1429
Modified Rotating-Sector Method of Measuring Kinetic Chain Lifetimes (Dr W I Bengough, S A McIntosh and R A M Thomson), 266
Modify the Normal Metabolism of Strontium-90 in Rats Attempts to (Dr V Volf), 1401
Modulation (Amplitude-) Radio-Telemetry of Nerve Action Potentials (Roger M Morrell), 1129
Moe, Dr Henry Allen Rôle of the Scholar in Society, 7
Moffitt, Prof William *Obituary* by Prof E Bright Wilson, jun , 21
Moguilevsky, Jaime A , and others The C_{17}-OH Group of Œstradiol—Relationships between its Anti-Atherogenic and Endocrine Actions, 1720
Mohole (AMSOC's) A Bore-Hole to the Earth's Mantle— (Gordon Lill and Willard Bascom), 140
Mohorovičić Discontinuity, etc Depth of Isostatic Compensation and, in Continental and Oceanic Areas (J N Nanda), 629
Moilliet, A , and others A Spectrum of Turbulence at Very High Reynolds Number, 808
Moir, G F J Ultracentrifugation and Staining of *Hevea* Latex, 1626
Moiseiwitsch, B L , and others Ionization Phenomena in Gases (Theoretical Calculation of the *1s*–*2p* Electron Excitation Cross-section of Atomic Hydrogen), 1354
Moisissures du Sol et des Litières de la Région de Yangambi (J Meyer), 236
Moisture Probing Behaviour of *Aedes aegypti* (L) in Response to Heat and (L Burgess), 1968
Moisture (Atmospheric) Absorption of, by Freeze-dried Pork and Fish (Norman A Matheson), 1949
Moisture Expansion (Permanent), of Clay Products on Natural Exposure (J S Hosking and H V Hueber), 1373
Molds The Cellular Slime (Prof John Tyler Bonner), *review* by D Park, 1976
Mole, Dr J H Modern Network Theory in Electrical Engineering (Design and Construction of Filter Networks), 1692
Molecular Approach to the Problem of Viscoelasticity (Prof Alfred H Nissan and H G Higgins), 1477
Molecular Compounds High (published in the Russian language by the Academy of Sciences of the U S S R), 410
Molecular Oxygen Incorporation of, in Bacterial Cells utilizing Hydrocarbons for Growth (E R Leadbetter and J W Foster), 1428
Molecular Shape and the Physical Properties of Mucin (R A Gibbons), 610
Molecular Weight (High) Ribonucleic Acids from the Nuclei of Calf Thymus (Dr Ping-yao Cheng), 190
Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods (Colloque AMPERE and the Radiofrequency Spectroscopy Group Joint Discussion on), 157
Molecular and Atomic Motions by Radio-Frequency Methods Maxwell–AMPERE Conference (Dr J G Powles), 157
Molecules (Organic) Steric Effects in, *review* by Dr G Eglinton, 1522
  An X-Ray Study of Rigid-Body and Internal Vibrations of (Dame Kathleen Lonsdale and Dr H Judith Milledge), 1545
Molecules (Protein) The Shape of, suggested by Electron Microscopy (Dr R C Valentine), 1838
Molecules (Two), of Palmitic Acid Biosynthesis of Corynomycolic Acid from (Dr Mireille Gastambide-Odier and Prof E Lederer), 1563
Mølgaard, J Fibre Surface Replication by Rolling, 264, 1478
Molinatti, Dr G M , and others Abolition by Chlorpromazine of the Inhibiting Effect of Iproniazid on the Depletion of Adrenal Catechol Amines induced by Reserpine, B A 65
Mollusc *Neomenia carinata* Tullberg Development of the Aplacophorous (Dr T E Thompson), 122
Molluscan Fauna of the Netherlands, 1612
Molluscs (Lamellibranch) Evidence for a Sliding Filament Contractile Mechanism in Tonic Smooth Muscles of (Dr Jean Hanson and Dr J Lowy), 286
Molybdenum Dislocation Arrangements in (J F Kerridge, A A Johnson and H I Matthews), 356
  Impact Ductile (J A Belk), 897
Molybdenum(II) Polynuclear Complexes of (Dr J C Sheldon), 1210
Molozzi, A R , and others Measurement of Cosmic Noise at Low Frequencies above the Ionosphere, 785
Monamycin, a New Antibiotic (Prof C H Hassall and K E Magnus), 1223
Monatomic Liquids including Metallic Liquids A Structural Model for (Dr Kazuo Furukawa), 1209
Mond Nickel Co , Ltd A New Alloy for Gunmetal, 1025
Mond Nickel Fellowships awarded to D J O Mann and N J B Pocock, 1272
Monde Le Systeme du—Histoire des Doctrines Cosmologiques de Platon a Copernic (Prof Pierre Duhem), Tome 10, *review* by Prof E J Dijksterhuis, 836
Mondovi, B , and others Degradation of Thiotaurine by Ionizing Radiations, B A 61
Mongolian Wild Horse, *Equus przewalskii* (A G Bannikov), 1024 , (E. Dagva), 1024 , (D Tzevegmid), 1024 , (I S Sles), 1024
Mongolism Urinary Excretion of β-Aminoisobutyric Acid in (Dr Thomas L Perry, Dr Kenneth N F Shaw and Dr Dorothy Walker), 1970
Monier, R (Ekert, B , and) Structure of Thymine Hydroperoxide produced by X Irradiation, B A 58
Monk, Marilyn (Holloway, Dr B W , and) Transduction in *Pseudomonas aeruginosa*, 1426
Monkey Foetal Haemoglobin in the (Dr G H Beaven and W B Gratzer), 1730
  Vagal Afferents in the (Prof Kent M Chapman and Prof James W Pearce), 1237
Monkey Kidney Cell Cultures infected with Poliomyelitis Virus and Incubated at 22-30°C Appearance of Crystalline Needles in (Dr Esther Tenenbaum), 1657
Mono- and Sesquiterpenoids (P de Mayo), (The Chemistry of Natural Products, Vol 2), *review* by Prof A J Birch, 754
Monoamine Oxidase in the Developing Rat Brain Histochemical Study of (Nobuo Shimizu and Nogaaki Morikawa), 650
Monod, J Cytoplasmic Inheritance (Inducible Permeation Factors and Cellular Memory in *Escherichia coli*), 1012
Monoethylaminoazobenzene Incorporation of N-Methyl Carbon of, into Polar Dyes (Prof Hiroshi Terayama, Prof Morizo Ishidate and Akira Hanaki), 1460
Monolayers Adsorbed from Solution Concentration of Stearic Acid in (George L Gaines, jun), 1139
Monolayers (Pig Kidney Tissue Culture) Effect of Proflavine on the Formation of the Virus of Foot-and-Mouth Disease and its Infective Ribonucleic Acid in (F Brown and Doreen L Stewart), B A 74
Monosaccharide Transport in Rat Diaphragm Muscle (F C Battaglia and P J Randle), 1713

Monovalent Cations and the Incorporation of Metabolites by Isolated Thymus Nuclei (Dr Theodore R Breitman and Dr George C Webster), 637
Monroe, Ronald E Rôle of Cholesterol in House Fly Reproduction, 1513
Monroy, Alberto (Maggio, Rachele, and) An Inhibitor of Cytochrome Oxidase Activity in the Sea Urchin Egg, 68
Montgomery, Dr Nancy Appointed lecturer in botany at the University of Birmingham, 1362
Montgomery of Alamein, Viscount New Engineering Building of the University of Glasgow inaugurated by, 1915
Montmorillonite Complexes Birefringence of (R Greene-Kelly), 181
Montreal Ninth International Botanical Congress, 1200
Montroll Prof E W Fluctuation Phenomena and Stochastic Processes (Stochastic Treatment of Traffic Flow), 512
Moodie, G C The Universities—a Royal Commission?, 1432
Mookerjee, A Effect of X-Radiation on the Survival of Yeast in Dry and Wet Conditions, 1502
Moon Absence of Craters on the Far Side of the (David B Beard), 1631
Volcanic Activity on the (N A Kozyrev), 856
Volcanoes on the (Dr Maurice W Windsor), 1556
Moore, Dr A W, and Abaelu, J N Non-Symbiotic Nitrogen Fixation in a Soil of the Nigerian Rain-Forest Zone, 75
Moore, C G, and others Incorporation of DL [2-^{14}C] Mevalonic Acid Lactone into Polyisoprene, 268, *erratum* 772
Moore, Dr M N Fluctuation Phenomena and Stochastic Processes (Stochastic Kinetics of Nuclear Reactors), 510
Moore, N W, and Rowson, L E A Maintenance of Pregnancy in Ovariectomized Ewes by means of Progesterone, 1410
Moore, Patrick Observations of the Russian Moon Rocket *Lunik II*, 502
Moore, P G Principles of Statistical Techniques, *review* by W J Langford, 1523
Moore, Dr Thomas Ubiquinone and Vitamin E, 607
Moore, W C British Parasitic Fungi, *review* by Dr Lilian E Hawker, 1977
Mora, P T, and others Reduction of Toxicity of Cationic Macromolecules by Complexing with Anionic Derivatives of Synthetic Polyglucoses, 431
Moran, P A P Genetical Effects of Population Subdivision, 505
Morawiecka, B, and others Regeneration of Protein from Insoluble Protein-Tannin Compounds, 1799
Morbidity Statistics from General Practice, Vol I, General (Studies on Medical and Population Subjects No 14), (Dr W P D Logan and A A Cushion), 154
Mordell, Prof L J Reflections of a Mathematician, 681
More Land-Use Planning (Prof L Dudley Stamp), 27
Morehead, F F, and others Liquid Crystal Systems from Fibrillar Polysaccharides, 632
Morel, F, and others Natriferin, a New Hormonal Principle in the Neurohypophysis of certain Vertebrates, 1236
Moreland, Dr J D and Thurlow, S J Biomechanics (Problems connected with Road Crash Injuries), 513
Morgan, Prof Councilman · Viral Multiplication and Cellular Hyperplasia, 435
Morgan, Dr D O *Obituary* by Dr E J L Soulsby, 1684
Morgan, E J Thermonuclear Research (Shock Waves in Gases), 1018
Morgan, M B Opening Address at the Royal Aeronautical Society Discussion on Structural Effects of Kinetic Heating, 30
Morgan, Dr T B, and Yudkin, Prof John Thiamine-sparing Action of Sorbitol in Rats and Mice, 909
Morgan, Dr W B Appointed lecturer in geography at the University of Birmingham, 684
Morgans, Dr J F C The North Kenya Banks, 259
Morice, Prof P B Linear Structural Analysis, *review* by R K Livesley, 1600
Morikawa, Nogaaki (Shimizu, Nobuo, and) Histochemical Study of Monoamine Oxidase in the Developing Rat Brain, 650
Moritz, A G At the Second Australian Spectroscopy Conference (Overall Appearance of the 3000 cm^{-1} Region in the Infra-red Spectra of a number of Methyl-substituted Polycyclic Hydrocarbons), 1106
Morley, J G Strength of Glass Fibres, 1560
Morphine Administration (Acute and Chronic) Noradrenaline and Adrenaline in the Rat Brain during, and during Withdrawal (Dr Lars-M Gunne), 1950
Morphogenesis Thiol Groups and (Prof J Brachet), 1074
Morphological Forms (Diverse), in *Convolvulus pluricaulis* Chois Intraspecific Polyploidy and Evolution of (Dr S L Tandon and C P Mzalik), 481
Morphological Variants of *Streptomyces erythreus* Strains An Electron-Microscopic Study of Spores of (L Dolezilová, Z Vanek and O Králík) 1888
Morphological and Chemical Observation Phylogeny of the Genus *Aniba* Aubl —a Comparative (Walter B Mors, Otto Richard Gottlieb and Ida de Vattimo), 1589
Morphology Continuous-Flow Culture of the Filamentous Mould *Penicillium chrysogenum* and the Control of its (S J Pirt and D S Callow), 307
Plant, *review* by Dr S Williams, 84
Morphology (Comparative), of Vascular Plants (Adriance S Foster and Ernest M Gifford, Jr), *review* by Dr S Williams, 84
Morphology (Floral), and the Taxonomy of Eucalyptus (Dr D J Carr and S G M Carr) 1549
Morphology (Fungal Spore) '*LO*-Analysis' as an Aid in the Study of (Dr M M Payak), 738
Morphology (Invertebrate) Studies in—in honor of Dr Robert Evans Snodgrass on the occasion of his eighty-fourth Birthday (Smithsonian Institution, Miscellaneous Collections Vol 137), 591
Morrell, Roger M Amplitude-Modulation Radio-Telemetry of Nerve Action Potentials, 1129
Morris, B Transmission of Passive Immunity in an Insectivore, 1151
Morris, G C (Lyons, Dr L E, and) At the Second Australian Spectroscopy Conference (Spectra of Aromatic Hydrocarbons—Absorption of Anthracene Vapour), 1195
Morris, H J *Obituary* by Dr T H C Taylor, 1104
Morris, J F Chemistry of Propellants (Air-Burning Fuels—Physicochemical Reactions during Nozzle Flow), 779
Morrison, Dr M E S *Lepidurus arcticus* in the Irish Late-Glacial, 739
Morrison, Philip (Cocconi, Giuseppe, and) Searching for Interstellar Communications, 844
Morrison, R I, and Dekock, Dr P C Glyceric Acid in Broad Bean (*Vicia faba* L), 819
Morrogh, H British Cast Iron Research Association—Open Days, 323
Mors, Walter B, and others Phylogeny of the Genus *Aniba* Aubl —a Comparative Morphological and Chemical Observation, 1589
Mortality Rate and Tumour Incidence Latent Period of X-Ray Induced Ageing—a Study based on (Dr H I Kohn and Dr P H Guttman), 735
Morth, Dr H T (Johnson, D H, and) Value of Contour Analysis in Equatorial Meteorology, 1372
Mortimer, Dr C Higher Education in East Africa, 243
Mortimer, C T Thermodynamics (Experimental Thermochemistry), 1607
Mortimer, Ernest Blaise Pascal—the Life and Work of a Realist, *review* by F I G Rawlins, 388
Mortimer, P I (Clark-Lewis, Dr J W, and) Occurrence of 4-Hydroxypipecolic Acid in *Acacia* Species, 1234
Mortimore, C G (Whitney, N J, and) Isolation of the Antifungal Substance, 6-Methoxybenzoxazolinone, from Field Corn (*Zea mays* L) in Canada, 1320
Morton, Dr G Appointed to the University of London readership in operational research at the London School of Economics and Political Science, 1451
Morton, J K Origin and Dispersal of Flowering Plants (Higher Incidence of Polyploidy in the Cameroons Mountain Flora than in Lowland Ghana), 1200
Morton, Prof R A (Pitt, Dr G A J, and) Steric Aspects of the Chemistry and Biochemistry of Natural Products (*Cis-trans* Isomers of Retinene in Visual Processes), 948
Morton, Prof R K, and others Equilibrium Constant of the Galactokinase Reaction and Free Energy of Hydrolysis of Adenosine Triphosphate, 1925
Mosaic Virus (Arabis) Rôle of a Dagger Nematode (*Xiphinema* sp) in Outbreaks of Plant Diseases caused by (Dr B D Harrison and Dr C H Cadman), 1624
Mosaic Virus (Tobacco) Effect of Nitrous Acid on—Mutation or Selection ? (F C Bawden), B A 27
Replication of—Kinetics of Virus Protein and Ribonucleic Acid Biosynthesis (Prof Barry Commoner, Dr James A Lippincott and Dr Janey Symington), 1992, A Re-examination of Theories (Prof Barry Commoner), 1998
Rotational Friction Coefficients of Models of, and the Size of the Virus Particle (Dr A J Haltner and Dr B H Zimm), 265
Mosaic Virus (Tobacco), inactivated by Antibody Recovery of Infectious Nucleic Acid from (Dr Irving Rappaport), 1732
Mosaic Virus (Turnip Yellow) Nucleoprotein Particles with Differing Biological and Physical Properties (R E F Matthews), 530
Moser, H Thermodynamics (Physical Constants), 1608
Mosinger, Dr B, and others Passage of Insulin through the Wall of the Gastro-intestinal Tract of the Infant Rat, 1245
Mosquitoes (*Aedes*) Control of Hatching in the Prediapause Eggs of (Dr J D Gillett), 1621
Mosquitoes (*Mansonioides*) Age Determination in (R H Wharton), 830
Moss, A R The Electric Arc in Welding, 1031
Moss, F, and others Effect of Oxygen Tension on Haem and Porphyrin Biosynthesis, 1217
Moss, Dr T S Optical Properties of Semi-Conductors, *review* by Dr R A Hyman, 1754
Moth (Clothes), *Tineola bisselliella* (Humm) A Reduced Triphosphopyridine Nucleotide-linked Cystine Reductase in the (R F Powning and H Irzykiewicz), 1230
Moth (Hemileucine) Central Control of Interactions between Behaviour Patterns in a (Dr A D Blest), 1164
Mother-of-Pearl from Fossil Cephalopoda Conchiolin Remnants in (Dr Ch Gregoire), 1157
Mothicidal Rhodanine Derivatives (Frederick J Allan, G Graham Allan and Claud M'F M Neil), 1637
Motility (Intestinal) Reflex Inhibition of (Nils G Kock), 1069
Motion of a Piston in a Hypersonic Gun Tunnel Measurement of the Effects of Piston Mass and Bursting Pressure on the (B J Belcher), 1207
Motion of *Vanguard* Solar Effects in the (Dr Stanley P Wyatt), 351
Motions (Molecular and Atomic), in Liquids and Solids by Radiofrequency Methods (Colloque AMPERE and the Radiofrequency Spectroscopy Group Joint Discussion on), 157
Motor Behaviour Possible Rôle of Higher Proprioceptive Centres in the Perception of Visual Space and in the Control of (Dr B Gurevitch), 1219
Motor Behaviour (Emotional and), in Experimental Animals Differential Analysis of the Effects of Phenothiazine-Tranquillizers on (Dr M Taeschler and Dr A Cerletti), 823
Motz, Dr H Awarded a grant of £2,000 by the Paul Instrument Fund Committee of the Royal Society, 507
Mould (Filamentous), *Penicillium chrysogenum* and the Control of its Morphology Continuous-Flow Culture of the (S J Pirt and D S Callow), 307
Moullec, Dr J, and Fine, Dr J M Frequencies of the Haptoglobin Groups in 406 French Blood Donors, 196
Mountains (Theron), and Whichaway Nunataks, Antarctica Palaeomagnetism of some Dolerite Intrusions from the (D J Blundell and P J Stephenson), 1860
Mouse Distribution in the, of Lethal and Sub-Lethal Doses of Cottonmouth Moccasin Venom labelled with Iodine-131 (Prof J F Gennaro, jun, and H W Ramsey), 1244
Effect of Bacillus Calmette-Guerin Infection on Transplanted Tumours in the (Dr Lloyd J, Old, Dr Donald A Clarke and Dr Baruj Benacerraf), 291
An Exteroceptive Block to Pregnancy in the (Hilda M Bruce), 105
Hereditary Absence of the Spleen in the (A G Searle), 1419
Organ Cultures of Total Mammary Glands of the (Dr F J A Prop), 379
Mouse Ascites Tumour Cells Growth Inhibition of, by Powdered Tragacanth (Tragacanthae Pulvis, B P), (Dr E M F Roe), 1891

Mouse Blood (Injected) Abrogation by, of Protective Effect of Foreign Bone Marrow in Lethally X-Irradiated Mice (L J Cole and R M Garver), 1815
Mouse Brains infected with Tick-borne Encephalitis Virus Infectious Ribonucleic Acid from (F Sokol, H Libikova and J Zemla), 1581
Mouse Eggs Experiments on the Development of Isolated Blastomeres of (Dr Andrzej K Tarkowski), 1286
Mouse Plasma-Cell Neoplasm Bence Jones Proteinuria associated with a Transplantable (John L Fahey and Michael Potter), 654, *erratum*, 1108
Mouse Spleen (Intact) Decrease in Radiosensitivity of the, produced by Hypoxia (Dr L Weiss), 1156
Mouse Tissue (Lymphomatous) Partial Identification of Lysins and Agglutinins in (Dr Eric Ponder and Ruth V Ponder), 819
Mouse Tissues Ribonucleases of, and of the Ehrlich Ascites Tumour (K A O Ellem, J S Colter and Jeanne Kuhn), 984
Moussa, Dr Moufied A (Zaher, Dr M A, and) Relationship between Larval and Pupal Periods of some Lepidopterous Insects, 288
Moussa, Dr Tohamy A, and Banhawy, M Effect of Insecticides on the Bodies of Nissl and Neurofibrillae of the Locust, *Schistocerca gregaria*, 915
Move Microbes on the, *review* by Dr N Blakebrough, 1598
Movement Recording Eye (G H Byford), 1493
Moving Front of Carbohydrates, *review* by Dr Alfred Gottschalk, 662
Movšovič, M I Technical and Vocational Education in the U S S R, 504
Moysey, G F At the Conference of the Mammal Society of the British Isles (Automatic Records of Badgers Moving In and Out of their Setts), 30
Mucin Molecular Shape and Physical Properties of (R A Gibbons), 610
Mucklow, Prof G F Retirement from the Chance chair of mechanical engineering in the University of Birmingham, 502, work of, 502
Mucopeptides (Cell-Wall), of *Staphylococcus aureus* and *Micrococcus lysodeikticus* (H J Rogers and H R Perkins), 520
Mucopolysaccharides (Human Arterial) Anticoagulant Activity of (Prof John E Kirk), 369
Mucoproteins containing Neuraminic Acid Some Observations on certain (Dr S A Barker, Prof M Stacey, D J Tipper and J H Kirkham), B A 68
Mucoproteins (Tissue) Determination of (Luiz A Abreu and R Raposo Abreu), 2016
Mucosal Nerve Fibres Are, Essential for the Peristaltic Reflex ? (Dr K H Ginzel), 1235
Mucus (Fish) Species Specificity of (J M Barry and Prof Fergus J O'Rourke), 2039
Mueller, H Awarded a Research Fellowship in biochemistry in the University of Birmingham, 1688
Muench, Prof Hugo, and others Statement on Biological and Chemical Warfare, 1018
Mukherjee, D, and Khan, N A A New Enzyme System in the Tamarind, 1140
Mukherjee, H Amino-Acids of Red Sulphur Bacteria, 1742
Muller, Dr E A Ergonomics, its Place in Industry, B A 21
Muller, G T A (Cole, Dr A R H, and) At the Second Australian Spectroscopy Conference (Stable Conformations of a Series of Methyl-*cyclo*-hexanols), 1196
Muller, P At the 139th Annual Meeting of the Swiss Society for Natural Sciences (Le Pourquoi des Satellites Artificiels), 1454
Müller-Hillebrand, D Ionization Phenomena in Gases (Conditions under which Hydrogen–Air and Propane–Air Mixtures can be Ignited by Corona Discharges), 1355
Mulrow, Dr P J (Phillips, Dr J G, and) Failure of Corpuscles of Stannius from Winter Flounder (*Pseudopleuronectes americanus*) to Synthesize Adrenocorticosteroids *in vitro*, 558
Multiform Glioblastoma (Human) Electron Microscopical Structure of the Wall of Small Blood Vessels in (Dr S H M Nystrom), 65
Multimammate Rat Is the, a Natural Reservoir of *Borrelia duttoni* ? (Dr F Zumpt), 793
Multiple Fibres (Sub-Micron) High-Resolution Fibre Optics using (Dr N S Kapany), 881
Multiple Haemoglobins in Fish (Dr N Chandrasekhar), 1652
Multiple Sclerosis Geology and (Prof Harry V Warren), 561
Multiplication (Viral), and Cellular Hyperplasia (Prof Councilman Morgan), 435
Multiplication (Virus) Isolation of Tobacco Leaf Cells capable of supporting (Prof Milton Zaitlin), 1002
Multiplying HeLa Cells Deoxyribonucleic Acid Formation in (C L Smith, A A Newton and P Wildy), 107
Multi-range Voltmeter (A New), 'Taylormeter Model 100A' (Taylor Electrical Instruments, Ltd), 1026
Mulvaney, D J Dating of Australian Prehistory, 918
Mulvey, Roland H Giant Eggs of the Clover Cyst Nematode, *Heterodera trifolii* Goffart 1932, 1662
Mumford, A H Appointed engineer-in-chief in the General Post Office, 1531, work of, 1531
Mummery, P W, and others (edited by) The Economics of Nuclear Power, including Administration and Law, Vol 2, *review* by R Brightman, 1673
Munday, K A (Krishnaswamy, S, and) At the Conference of the Mammal Society of the British Isles (Filter-paper Electrophoresis on Blood Serum from various Murids), 30
Munday, K A, and others Electron Spin Resonance Investigations of *Allium cepa* and *Calliphora vomitoria*, 1402
Mung Bean Mitochondria Glutamic Dehydrogenase of (Dr D H Bone), 990
Munger, F, and others A Suspected Virus Disease of the Citrus Red Mite *Panonychus citri* (McG), 70
Munn, R I Thermodynamics (Phase Changes in Condensed Systems), 1609
Munro, Prof C N Watson Appointed to the chair of thermonuclear physics in the University of Sydney, 1912
Munsick, Robert A, and others Active Principles of the Neurohypophysis of Cold-blooded Vertebrates—Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates, 1464
Murata, M, and others Proof of the Formation of Enzyme-Substrate Complex by 'Crossing-Paper Electrophoresis', 638
Murgai, Prem *In vitro* Culture of the Inflorescences, Flowers and Ovaries of an Apomict, *Aerva tomentosa* Forsk, 72
Murmann, W, and others N-Substituted 7-Methoxy-8-Aminomethylchromes and Flavones—New Brain-Stem Stimulants, 362
Murnaghan, A R, and others Studies of Coal—Carbonization of Coals in the Presence of Activated Charcoal, 425
Murphy, Prof A J The Education of Technologists (Presidential Address to the Institution of Metallurgists), 514
Murphy, G Polar Front Survey (Biology—Productivity), 1183
Murray, III, Arthur, and Williams, D Lloyd Organic Syntheses with Isotopes, Part 2, Organic Compounds labelled with Isotopes of the Halogens, Hydrogen, Nitrogen, Oxygen, Phosphorus and Sulfur, *review* by Dr G Eglinton, 1830
Murray, C A An Error in the Determination of ΔT from the Lunar Ephemeris and the Frequency of Caesium in Terms of U T $+\Delta T$, 441
Murray, J D Appointed head of the Applied Metallurgy Section of the United Steel Companies, Ltd, 95
Murray, Sir Keith Elected president of the British Agricultural History Society, 1916
Murray, Prof Margaret M A Title of professor emeritus of physiology in the University of London conferred on, 508
Murrell, H Ergonomics, its Place in Industry, B A 21
Murrell, Dr J N Appointed lecturer in chemistry at the University of Sheffield, 684
Musa balbisiana A Rapid and Simple Pathogenicity Test for Detecting Virulent Clones of *Fusarium oxysporum* f *cubense* using Seedlings of (Dr R H Stover), 1591
Muscle Ionic Partition and Fine Structure in (Dr Shirley E Simon), 1978
Muscle (Frog Sartorius) Changes in Fluorescence in a, following a Twitch (Prof Britton Chance and Frans Jobsis), 195
Muscle (Rat Diaphragm) Monosaccharide Transport in (F C Battaglia and P J Randle), 1713
Muscle (Red Lateral), of Rainbow Trout Changes in Purine Nucleotides of (Tsuneyuki Saito, Ken-ichi Arai and Toshikatsu Yajima), 1415
Muscle (Striated) A Peripheral Effect of the Bromide Ion on the Contraction of (Dr D K de Jongh and H A Linnewiel), 1240
Muscle Cells of *Ascaris lumbricoides* Electrical Activity in the (Dr M Jarman), 1244
Muscle Contraction Permanent Set, Supercontraction and Urea-Bisulphite Solubility—the Proton-Transfer Nature of some Changes in Keratin and the Analogy with (Dr P T Speakman), 339
Muscle Fibres (Atrophic) Dissociation of the 'Surface Membrane Complex' in (Dr R Birks, Prof B Katz and Dr R Miledi), 1507
Muscle Fibres (Glycerol-extracted) Oxygen Uptake of (James A Wilson, Paul R Elliott, Prof Karl F Guthe and David G Shappirio), 1947
Muscle Mitochondria (Human Skeletal) Enzymic Activities of—a Tool in Clinical Metabolic Research (Dr L Ernster, Dr D Ikkos and Dr R Luft), 1851
Muscle Tissues Determination of Chlorine in, by Neutron Activation Analysis (Dr Jonas Bergstrom), 1504
Muscle and Nerve in Sodium-free Hydrazinium Solution Excitability and Phosphorylation of (L G Abood and K Koketsu), 725
Muscles (Isolated Plain) Promoting Effect of Urea on the *in vitro* Passive Sensitization of with Precipitating Antibody (R Binaghi, Dr B N Halpern, P Liacopoulos and T Neveu), 1805
Muscles (Tonic Smooth), of Lamellibranch Molluscs Evidence for a Sliding Filament Contractile Mechanism in (Dr Jean Hanson and Dr J Lowy), 286
Muscular Response Effects of Irradiation of Nerve on (A Portela, D Brandes, Prof G H Bourne, Marion Hines, P Stewart and B L Redd, jun), 734
Muscular Responses (Reflex) Does an Increase in the Tension in a Ligament elicit (Dr Bertil Stener), 1495
Museum The Country House and the (Museums Association Discussion on), 598
Museum of Applied Science, Victoria Report for 1957-58, 941
Museum of English Rural Life Report for 1958, 505
Museum of Science and Industry (Birmingham) Account of the Workshops reconstructed in the (Keith Dunham), 1534
Museum National d'Histoire Naturelle, Paris Celebration of the anniversaries of the 'Precurseurs et Fondateurs de l'Evolutionnisme—Buffon, Lamarck, Darwin', 859
Museum (Australian) Annual Report for 1957-58, 592
Museum (National), of Canada Bulletin No 139, Haida Carvers in Argillite (Prof Marius Barbeau), 409
  Bulletin 159 (Biological Series 57), Mammals of Banff National Park, Alberta (A W Banfield), 594
Museums (Bristol City) Retirement of Dr F S Wallis from the directorship, 1685
  Appointment of Alan Warhurst as director, 1686
Museums (Liverpool Public) Exhibition of Working Models of Marine Engines, 1534
Museums of Applied Arts and Sciences, Sydney Annual Report for 1957, 681
Museums as Mirrors—their Potentialities and Limitations (International Council of Museums Conference on), 504
Museums, International Council of Fifth General Conference (Museums as Mirrors—their Potentialities and Limitations), 504
  Inauguration of an International Centre for the Study of the Preservation and Restoration of Cultural Property, 504
Museums Association Sixty-fifth Annual Conference, 597
  Presidential Address (Dr W E Swinton), 597
  Discussion on Museums and Finance, 598
  Discussion on the Country House and the Museum, 598
  Re-election of Dr W E Swinton as president, 598
Museums and Finance (Museums Association Discussion on), 598
Music Experimental—Composition with an Electronic Computer (Prof L A Hiller, Jr, and Leonard M Isaacson), *review* by Prof E G Richardson, 1754
Music and Electronic Computers, *review* by Prof E G Richardson, 1754
Musicale Acoustique (Colloques Internationaux du Centre National de la Recherche Scientifique, No 84, Marseilles, 1959), *review* by Prof E G Richardson, 1902

Mutant (Nutritionally Deficient), of Pathogenic *Fusarium oxysporum* after Ultra-violet Irradiation Production of a Perfect Stage in a (E W Buxton), 1258
Mutants with Respiration-deficiency in *Staphylococci* Rate of Appearance of (G F Gause, G V Kochetkova and N A Sorbaeva), 1821
Mutants (Galactose-sensitive), of *Salmonella* (Toshio Fujasawa and Hiroshi Nikaido), 1168
Mutants (Sub-Genic), in the *r*-Locus of *Drosophila melanogaster* Complementation among the (Dr O G Fahmy and Dr Myrtle J Fahmy), 1927
Mutation of Bacteria at High Levels of Survival by Ethyl Methane Sulphonate (Anthony Loveless and Sheila Howarth), 1780
Mutation in the Type-determining Phages of *Salmonella typhi* (E S Anderson), 1822
Mutation (Gene) Human Haemoglobin *E*—the Chemical Effect of (Abnormal Human Haemoglobins), (Dr J A Hunt and Dr V M Ingram), 870
Mutation (A 'Progressive'), induced in *Poa pratensis* L by Ionizing Radiation (A A Hanson and F V Juska), 1000
Mutations A New Approach to the Mechanism of (Prof Paul Mandel and Pierre Chambon), 1501
Mutations (Induced), of X-Ray Irradiations in *Culex fatigans* Wied (1828), (R Pal and B S Krishnamurthy), 658
Mutch, R E, and Raal, Dr F A Electrical Resistivity Changes observed in a Semiconducting Diamond after Heat Treatment, 1857
Mutchmor, J A, and Mazurek, J H Chemical Changes associated with Diapause in the European Corn Borer, *Ostrinia nubilalis* (Hbn) (Lepidoptera Pyralidae), 1077
Mutual Solubility Data Estimation of the Interchange Energy for Binary Systems from (Kiyoharu Ishida) 814
Myasthenia Gravis Ultra-structure of the Myoneural Junction in (E R Bickerstaff, J V Evans and A L Woolf), 1500
Myatt, J, and others Ionization Phenomena in Gases (Influence of Gas Purity, Tube Geometry and Method of Calculation on the Determination of Ionization Coefficients in Hydrogen and the Inert Gases), 1354
Mycobacteria Nicotinamidase in—a Method for Distinguishing Bovine Type Tubercle Bacilli from other *Mycobacteria* (Dr Kiyoshi Konno, Dr Hideo Nagayama and Dr Sutemi Oka), 1743
Mycobacterium smegmatis Effect of Iron and Zinc on Nucleic Acid and Protein Synthesis in (Frank Winder and Joan M Denneny), 742
Mycobacterium tuberculosis $H_{37}Rv$ Effect of Cell-Free Extracts of, on Lung Succinooxidase (Dr A Bekierkunst and M Artman), 458
'Myleran' Metabolic and Chemical Studies of—Formation of 3-Hydroxytetrahydrothiophene-1,1-dioxide *in vivo*, and Reactions with Thiols *in vitro* (Dr J J Roberts and Dr G P Warwick), 1288
Myoglobin Binding of Haem to Protein in Haemoglobin and (Dr J E Falk, Dr J N Phillips and Dr D D Perrin), 1651 , (Dr J E O'Hagan), 1652
Myoneural Junction in Myasthenia Gravis Ultra-structure of the (E R Bickerstaff, J V Evans and A L Woolf), 1500
Myrbäck, Karl, and others (edited by) The Enzymes, Vol I, Kinetics, Thermodynamics, Mechanism, Basic Properties, second edition, *review* by Dr Edwin C Webb, 1759
Myth and Ritual in the Ancient Near East (Prof E O James), *review* by Prof Norman W Porteous, 1972
Myxoma Transformations of, into Vaccinia or Ectromelia Virus in Tissue Culture (Hidesaburô Hanafusa, Teruko Hanafusa and Juntarô Kamahora), 1152
Myxomatosis—Present Position and Future Prospects in Great Britain (Dr C H Andrewes, H V Thompson and W Mansi), 1179
Myxovirus Preparations Failure to Recover Infective 'Ribonucleic Acid' from (G L Ada, Patricia E Lind, Lois Larkin and Sir Macfarlane Burnet), 360
Mzalik, C P (Tandon, Dr S L, and) Intraspecific Polyploidy and Evolution of Diverse Morphological Forms in *Convolvulus pluricaulis* Chois , 481

NACHINGWEA Districts (Kongwa and), of Tanganyika A Survey of Soils in the (B Anderson), *review* by Dr R M S Perrin, 1901
Nadeau, Dr Guy (Joly, Dr Louis-P, and) Evidence of Side-Chain Cleavage during the Reaction of Epinephrine and Norepinephrine with Ethylene Diamine, 1483
Nadi-Positive Mitochondria, (*Gamma* Particles), and Development in the Water Fungi *Blastocladiella* and *Allomyces* (Prof Edward C Cantino and Gilbert Turian), 1889
Naets, Dr Jean-Pierre Disappearance of the Erythropoietic Factor from Plasma of Anaemic Dogs after Nephrectomy, 371
Näf, Dr Ulrich Control of Antheridium Formation in the Fern Species *Anemia phyllitides*, 798
Nagabhushanam, A K Feeding of a Ctenophore, *Bolinopsis infundibulum* (O F Muller), 829
Nagabhushanam, A K, and Colman, J S Carrion-Eating by Ophiuroids, 285
Nagata, T, and Shimizu, Y Natural Remanent Magnetization of Pre-Cambrian Gneiss of Ongul Islands in the Antarctic, 1472
Nagata, T, and Uyeda, S Exchange Interaction as a Cause of Reverse Thermo-Remanent Magnetism, 890
Nagatsu, Dr Ikuko, and others Effect of Flavins on Cramp caused by Phenol, 1648
Nagatsu, Dr Toshiharu (Yagi, Dr Kunio, and) Formation of Noradrenaline from Adrenaline by Rat Liver Mitochondria, 1316
Nagatsu, Dr Toshiharu, and others Complex Formation of Chlorpromazine with Flavins, 982
Nagayama, Dr Hideo, and others Nicotinamidase in *Mycobacteria*—a Method for Distinguishing Bovine Type Tubercle Bacilli from other *Mycobacteria*, 1743
Naka, K (Kuwabara, M, and) Response of a Single Retinula Cell to Polarized Light, 455
Nakahara, Hiroshi, and others Inhibition of Skeletal Formation in the Chick Embryo following Administration of Tetracycline, 728
Nakahara, Tomoko (Amaha, Prof Mikio, and) Rôle of the Glycolytic Enzyme System in the Germination of Spores of *Bacillus coagulans* var *thermoacidurans*, 1255
Nakahira, M Clay Minerals (Thermal Changes in Kaolinite), 780
Nakamura, Prof S, and others Proof of the Formation of Enzyme-Substrate Complex by 'Crossing-Paper Electrophoresis', 638
Nakayama, T O M (Friend, J, and) Destruction of Carotenoids in Isolated Chloroplasts, B A 66
Naked Protoplasts of Yeasts Nuclear Structure of Growing (Dr O Necas), 1664
Nakkash, Sanniyah (Keehn, Prof J D, and) Effect of a Signal Contingent upon an Avoidance Response, 566
Nalivkin, Academician D V Elected to foreign membership of the Geological Society of London, 1360
Nanda, J N Depth of Isostatic Compensation and Mohorovičic Discontinuity, etc , in Continental and Oceanic Areas, 629
Nanney, D L Cytoplasmic Inheritance (Mating Types in Protozoa), 1012
α-Naphthalene Acetic Acid Effect of Indole Acetic Acid and, on the Growth, Flowering and Fruit Set in Sweet Potato (G Satyanarayana and Dr G Rangaswami), B A 73
Napier, D H, and others Studies of Coal—Carbonization of Coals in the Presence of Activated Charcoal, 425
Narasimhan, K S, and others Insecticidal Effects of Activated Charcoal and Clays, 1165
Narrow-Band Spectrum Analyser Observations of the Fine Structure of Enhanced Solar Radio Radiation with a (Oystein Elgaroy), 887
Narrow Tubes The Flow of Blood through (Prof M Reiner and Dr G W Scott Blair), 354
Narurkar, M V, and others Inhibition of Tumour Growth with 2- 5-Dicarbethoxy-3 4-Dihydroxy-Thiophene, 201
Nasal Gland (Salt Gland) Captive Marine Birds possessing a Functional Lateral (Prof Larry Z McFarland), 2030
Nasanen, Prof Reino (Albert, Prof Adrien, and) Stability of Metal Complexes of Oxine and its Sulphonic Acid, 449
Nath, Prof M C, and others Chromatographic Identification of the Antilipaemic X Factor of the Unsaponifiable Fraction of Crude Vegetable Oils, 1635
National Academy of Sciences (United States) Election of foreign associates, 95
National Academy of Sciences (United States)—National Research Council Conference on the Atomic Mechanisms of Fracture, 324
  Report for 1957-58, 697
  Developmental Biology Conference Series, 1956—Cytodifferentiation (edited by Dorothea Rudnick) , Environmental Influences on Prenatal Development (edited by Beatrice Mintz) , Regeneration in Vertebrates (edited by Charles S Thornton) , Embryonic Nutrition (edited by Dorothea Rudnick) , Immunology and Development (edited by M V Edds, Jr) , Dynamics of Proliferating Tissues (edited by Dorothy Price) , Wound Healing and Tissue Repair (edited by W Bradford Patterson), *review* by Dr D R Newth 839
  Grants-in-aid for Research in Problems of Sex, 1107
National Academy of Sciences (United States)–National Research Council (Committee on Fire Research and the Fire Research Conference of the Division of Engineering and Industrial Research) Symposium on the Use of Models in Fire Research 772
National Academy of Sciences (United States), and the Academy of Sciences of the U S S R Exchange visits by research scientists of each country, 680
National Bureau of Standards (United States) *Journal of Research* to be published in four separate Sections, 320
  Handbook 69, Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure, 939
National Chemical Laboratory Retirement of Dr D D Pratt from the directorship, 1610
  Appointment of Prof J S Anderson as director, 1610
  Report for 1958, 1779
National Coal Board Grant of £4,310 to the University of Leeds, for six research projects in mining, 1534
  Grant of £1,150 to the Department of Physical and Inorganic Chemistry in the University of Bristol, for a study of carbon sufaces and surface complexes by infra-red spectroscopy, and £1,100 for a study of reactivity of carbon surfaces with oxygen, 1613
National Coal Board (North-Eastern Division) Grant of £3,000 to the University of Leeds, for research in mining, 1108
National Collection of Industrial Bacteria Transferred from the National Chemical Laboratory to the Torry Research Station, 1192
National Committee for Geodesy and Geophysics Appointment of J Connor as chairman, 1192
National Health Service Hospitals and the State—Hospital Organization and Administration under the, Sixth and Final Research Report (Creative Leadership in a State Service—a General Survey by Sir George Schuster), 1087, 1201
National Industrial Conference Board, Inc , Cleveland Seventh Annual Conference on Atomic Energy in Industry (Radiation, a Tool for Industry), 506
National Institute of Adult Education After Work—Leisure and Learning in Two Towns (R Ruddock and Dr A Wilson), 1034
National Institute of Agricultural Botany Leaflets on Fodder Beet, Mangels and Swedes, 1777
National Institute of Economic and Social Research The Structure of British Industry, a Symposium (edited by Duncan Burn), *review* by Prof A J Brown, 1089
National Institute of Industrial Psychology Grant of £6,000 a year for five years from the Department of Scientific and Industrial Research, 940
  Vernon Prize for 1960, 1450
National Institute for Research in Dairying Annual Report for 1958, 770
  Grant of 89,348 dollars from the Population Council, Inc , New York, in support of researches on cervical mucus, with particular reference to the control of fertility, 1362
National Institute for Research in Nuclear Science Contracts for work on the 7,000-MeV Proton Synchrotron *Nimrod*, B A 14
National Institutes of Health (United States) Ninth Annual Instrument Symposium and Research Equipment Exhibit, 26
  Grant of 1,482,480 dollars to the University of Texas, for basic research in genetics and cell biology, 1108
National Institutes of Health (United States) (Endocrinology Study Section) Free distribution of Pituitary Hormones, 1272

National Joint Advisory Council Report of an Inquiry into the Efficient Use of Man-power in Industry (Ministry of Labour and National Service), 25
National Lending Library for Science and Technology Appointment of a Consultative Committee, 1449
National Museum of Canada Bulletin No 139, Haida Carvers in Argillite (Prof Marius Barbeau), 409
  Bulletin 159 (Biological Series 57), Mammals of Banff National Park, Alberta (A W Banfield), 594
National Park (Banff), Alberta Mammals of (A W Banfield), 594
National Parks and Nuclear Power Stations in Britain, 1005
National Physical Laboratory Open Days, 773
  New Ship Hydrodynamics Laboratory at Feltham, 926
  Report for 1958, 954
  Appointment of Dr G Macfarlane as deputy director, 1844
National Radio Astronomy Observatory (United States) Appointment of Prof Otto Struve as first director, B A 14
National Research Council (United States National Academy of Sciences—) Conference on the Atomic Mechanisms of Fracture, 324
  Report for 1957-58, 697
  Developmental Biology Conference Series, 1956—Cytodifferentiation (edited by Dorothea Rudnick), Environmental Influences on Prenatal Development (edited by Beatrice Mintz), Regeneration in Vertebrates (edited by Charles S Thornton), Embryonic Nutrition (edited by Dorothea Rudnick), Immunology and Development (edited by M V Edds, Jr), Dynamics of Proliferating Tissues (edited by Dorothy Price), Wound Healing and Tissue Repair (edited by W Bradford Patterson), *review* by Dr D R Newth, 839
  Grants-in-aid for Research in Problems of Sex, 1107
National Research Council (United States) (Committee on Fire Research and the Fire Research Conference of the Division of Engineering and Industrial Research of the United States National Academy of Sciences—) Symposium on the Use of Models in Fire Research, 772
National Research Council of Canada Formation of an Associate Committee on Space Research, jointly with the Defence Research Board, 24
  Scholarships for 1959-60, 26
  Forty-second Annual Report (1958-59), including the Annual Report of Canadian Patents and Development, Ltd, 1916
National Science Foundation (United States) Grant of 250,000 dollars to the United States Naval Research Laboratory, for rocket observations of ultra-violet and X-ray emissions from solar flares, 406
  Reviews of Data on Research and Development No 13, Research and Development and Economic Growth (Dr A T Waterman), 591
  To establish and maintain a Programme of National Information on Scientific and Technical Personnel, 592
  Resignation of Dr David D Keck as acting director of the New York Botanical Garden in order to remain permanently as programme director for systematic biology at the Foundation's Division of Biological and Medical Sciences, 680
  Grant of 250,000 dollars to the Woods Hole Oceanographic Institute, 683
  Grant of 171,600 dollars to the Bernice P Bishop Museum, Hawaii, 683
  Grant of 162,000 dollars to the Marine Laboratory, University of Miami, 683
  Grant of 155,000 dollars to the California Institute of Technology, 683
  Grant of 150,000 dollars to the University of Chicago, 683
  Grant of 135,000 dollars to the Long Island Biological Association, 683
  Grant of 105,000 dollars to the Woods Hole Marine Biological Laboratory, 683
  Formation of an Advisory Panel on Atmospheric Sciences, 1022
  Reviews of Data on Research and Development, No 14, Funds for Research and Development Performance in American industry, 1022
  Reviews of Data on Research and Development, No 15, Grants for Private Philanthropic Foundations during 1957, 1272
  Postdoctoral Fellowships, 1534
  Providing United States Scientists with Soviet Scientific Information, revised edition, 1611
  Appointment of Dr Bowen C Dees as assistant director for scientific personnel and education, 1686
  Grant of 3,000,000 dollars to the Woods Hole Oceanographic Institution, for a new Research Vessel, 1686
National Service Graduates and, 406
National Symposium on Reliability and Quality Control in Electronics Sixth, 1362
National Trust Sixty-fourth Annual Report (1958-59), 1687
National Union of Students 1959 Grants Year Book, 770
National Vegetable Research Station New Laboratory Building (J A Nelder), 1368
Native Life in Angola, 236
Native Pinewoods of Scotland (Prof H M Steven and A Carlisle), *review* by Prof E W Jones, 133
Native and Denatured Deoxyribonucleates Aggregation of an Acridine Dye on (Dr D F Bradley and Dr G Felsenfeld), 1920
NATO Election of Ernest Turner Jones as deputy chairman of the Advisory Group for Aeronautical Research and Development, 1108
  British Aid for Scientific Courses, 406
Natriferin, a New Hormonal Principle in the Neurohypophysis of certain Vertebrates (J Maetz, F Morel and B Lahlouh), 1236
Natta, G Macromolecules (Stereospecific Polymerization), 1689
Natural Animal Populations Exploitation of (British Ecological Society Symposium on), 1451
Natural Exposure Permanent Moisture Expansion of Clay Products on (J S Hosking and H V Hueber), 1373
Natural History in the Midlands, 1024
Natural History, American Museum of Bulletin, Vol 117, Art 6, Studies on Social Groupings in Fishes (Dr C M Breder, Jr), 865
  Bulletin, Vol 117, Art 5, A Taxonomic Revision of the Spotted Skunks of the Genus *Spilogale* (R G van Gelder), 1024
  James Arthur Lecture on the Evolution of the Human Brain—The Discrete and the Diffuse in Nervous Action (Prof D P C Lloyd), 1777
Natural History and Philosophical Society (Birmingham) Records and Activities (K L Kenrick), 1024
Natural Philosophy and related Documents Papers and Letters on (Isaac Newton), edited with a General Introduction by I Bernard Cohen, assisted by Robert E Schofield, *review* by Dr M A Hoskin, 1570
Natural Products The Chemistry of, Vol I, The Alkaloids (K W Bentley), Vol, 2, Mono- and Sesquiterpenoids (P de Mayo), Vol 3, The Higher Terpenoids (P de Mayo), *review* by Prof A J Birch, 754
  Steric Effects of the Chemistry and Biochemistry of (Biochemical Society Symposium on), 947
Natural Remanent Magnetization of Pre-Cambrian Gneiss of Ongul Islands in the Antarctic (T Nagata and Y Shimizu), 1472
Natural Reservoir of *Borrelia duttoni* Is the Multimammate Rat a (Dr F Zumpt), 793
Natural Sciences, Swiss Society for 139th Annual Meeting (Dr R C H Tanner), 1454
  Presidential Address, La science, le savant et le pharmacien (Prof A Girardet), 1454
Natural and Historical Monuments and Relics, Southern Rhodesia (Commission for the Preservation of) Khami Ruins—Report on Excavations, 1947-1955 (K R Robinson), *review* by R R Inskeep, 1349
Natural and Synthetic Diamond Spiral and other Growth Forms of Synthetic Diamonds—a Distinction between (Prof S Tolansky and Dr I Sunagawa), 1526
Naturalists A New Service for (R S R Fitter), 1774
Naturally Occurring Potash Salts Biological Action of Potassium-40 in (Prof E Welte and Kl Mechsner), 1958
Nature and the Recent Printing Dispute, 919
Nature, Council for Resolutions passed at the Annual General Meeting, 769
  Work of the Intelligence Unit, 1774
Nature of Experience (Sir Russell Brain), *review* by F I G Rawlins, 218
Nature of the Olefines produced by Apples (Dr F E Huelin and B H Kennett), 996, *errata*, 1535 (Dr D F Meigh) 1072
Nature of Polished Metal Surfaces (L E Samuels), 1280
Nature and Agriculture (Dr E B Worthington), 1535
Nature (Chemical) of a Plant-Virus Inhibitor from Rice (W A Jones, M Jacobson and R P Kahn), 1146
Nature (Proton-Transfer), of some Changes in Keratin and the Analogy with Muscle Contraction Permanent Set, Supercontraction and Urea-Bisulphite Solubility—the (Dr P T Speakman), 339
Nature Conservancy Awards of research studentships for postgraduate training in ecology, 156
  Special Promotion, 859
  Grant of £4,900 to the Department of Geography in the University of Hull, for an investigation into the coastal geomorphology of Holderness and Spurn Head, 1273
  Dungeness and the, 1533
Nature Conservation and Youth Service in Britain (Brigadier E F E Armstrong), 685, (Edie J Green), 685
Naughton, Prof John J, and Fujikawa, Yasuo Measurement of Intergranular Diffusion in a Silicate System—Iron in Forsterite, B A 54
Naval Research, United States Office of Second Conference on Semiconductor Surfaces, 1192
Naval Research Laboratory (United States) Grant of 250,000 dollars from the United States National Science Foundation, for rocket observations of ultra-violet and X-ray emissions from solar flares, 406
Nave, E, and others Transformation of a Cubic Boron Nitride to a Graphitic Form of Hexagonal Boron Nitride, 715
Navigable Waters Oil in (P Barclay-Smith), 949
Nawa, Hayao, and others Microbiological Transformation of a Cardiac Aglycone, 469
Nayler, Winifred G, and McCulloch, Marian Positive Inotropic Activity of Cytidine Triphosphate, 67
Naylor, G R E, and Adair, M E Serological Distinction of Adult and Foetal Human Haemoglobin, 1854
Naylor, J M (Black, Dr M, and) Prevention of the Onset of Seed Dormancy by Gibberellic Acid, 468, *erratum*, 857
Neale, Dr S A (Johnson, G A, and) Dielectric Absorption in Dispersed Systems, 898
Near East (Ancient) Myth and Ritual in the (Prof E O James), *review* by Prof Norman W Porteous, 1972
Near Infra-Red System of Nitrogen (Dr P K Carroll and Dr H E Rubalcava), 119
Nebel, B (Campbell, W H, and) Micropulsation Measurements in California and Alaska, 628
Neberkern Absorbancy Measurements on the (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Dr Robert P Perry, Dr Bo Thorell, Dr Lennart Åkerman and Prof Britton Chance), 929
Nečas, Dr O Nuclear Structure of Growing Naked Protoplasts of Yeasts, 1664
Necrosis (Lymphoid), Induced by Lipid Emulsions (Dr A A Shivas and Dr G P Fraser) 1813
Need for Inorganic Phosphate in Oxidations stimulated by Dinitrophenol (P Borst and Prof E C Slater), 1396
Need for Marine Research, *review* by Dr F S Russell, 129
Needham, George Herbert The Practical Use of the Microscope, *review* by Dr S Bradbury, 1174
Needham, Dr Joseph A History of Embryology, second edition, *review* by Sir Julian Huxley, 1176
  The Development of Iron and Steel Technology in China (Second Biennial Dickinson Memorial Lecture to the Newcomen Society 1956), *review* by Prof F C Thompson, 1830
Needham, J C The Electric Arc in Welding, 1031
Needham, R M Classification, Concept-formation and Language, 1194
Needle Transmission of a New Maize Virus (Dr I Harpaz), B A 77
Needles (Crystalline) Appearance of, in Monkey Kidney Cell Cultures infected with Poliomyelitis Virus and Incubated at 22-30°C (Dr Esther Tenenbaum), 1657
Neef, Prof Ernst Elected a member of the Geography Section of the Leopoldina Academy of Natural Sciences, 595
Neely, W Brock, and Thompson, C F Kinetic Study of Dextransucrase based on the Langmuir Adsorption Isotherm, B A 64
Negishi, Takashi (Fujino, Prof Yasuhiko, and) Presence of Behinic Acid in Sphingomyelin from Horse Spinal Cord, 817
Neher, Prof H V Change of Cosmic Rays in Space, 423

Neher, R , and others 3,4,ω-Trihydroxyacetophenone 3-methyl Ether in Adrenal Extracts, 268
Neilands, Dr J B , and Stumpf, Dr Paul K Outlines of Enzyme Chemistry, second edition, *review* by Dr Edwin C Webb, 1759
Neilands, Dr J B (Emery, Dr T , and) The Iron-Binding Centre of Ferrichrome Compounds, 1632
Nelder, J A National Vegetable Research Station—New Laboratory Building, 1368
Nelson, C D , and Gorham, P R Translocation of Carbon-14-labelled Amino-Acids and Amides in the Stems of young Soya Bean Plants, 855
Nelson, J B Awarded a Nature Conservancy Research Studentship for post-graduate training in ecology (zoology), 156
Nematicide Formulations (Soil Insecticide and) Effect of Emulsifiers and Organic Diluents in (F T Phillips), 1512
Nematode *Trichostrongylus retortaeformis* (Zeder, 1800) A Seasonal Sex Difference in the Infestation of Rabbits with the (P C Bull), 281
Nematode (*Xiphinema* sp) Transmission of a Virus to Strawberry Plants by a (Asharfi Jha and Dr A F Posnette), 962, *erratum*, 1192
Nematode (Clover Cyst), *Heterodera trifolii* Goffart, 1932 Giant Eggs of the (Roland H Mulvey), 1662
Nematode (Dagger), *Xiphinema* sp Rôle of a, in Outbreaks of Plant Diseases caused by Arabis Mosaic Virus (Dr B D Harrison and Dr C H Cadman), 1624
Nematode (Southern Root Knot) A Virus Disease of *Meloidogyne incognita incognita*, the (J R Loewenberg, T Sullivan and M L Schuster), 1896
Nematode Populations Effective Increase in, by the Addition of Aureomycin (C O R Everard and William A Feder), 1887
Nematodes Plant (Dr Jesse R Christie), *review* by Dr W G Inglis, 1349
Nematodes (Dagger), associated with a Clover Sickness (F C Peacock), 123
Nematology Plant (Ministry of Agriculture, Fisheries and Food, Technical Bulletin No 7), 855
Neomenia carinata Tullberg Development of the Aplacophorous Mollusc (Dr T E Thompson), 122
Neoplasia Cell Physiology of (University of Texas Anderson Hospital and Tumour Institute fourteenth Annual Symposium on Fundamental Cancer Research), 1451
Neoplasm (Transplantable Mouse Plasma-Cell) Bence Jones Proteinuria associated with a (John L Fahey and Michael Potter), 654, *erratum*, 1108
Neoteny in the Genus *Artemia* Occurrence of (Inder Chand Baid), 73
Neotropical Element (*Anoplotermes*) in Indian Termite Fauna New (Dr M L Roonwal and O B Chhotani), 1967
Neotropischen Fauna Beitrage zur (herausgegeben von Prof Dr Erich Titschack und Dr Hans-Wilhelm Koepcke), Band 1, Heft 3, Zur Kenntnis der Pseudoscorpioniden-Fauna des Andengebietes (Max Beier), Kritische Untersuchungen der Newportia-Arten (Wolfgang Bucherl) , Ein neuer *Asthenes* (Aves, Furnariidae) von der Kuste und dem westlichen Andenabhang Sudperus (Maria Koepcke) , Beitrage zur Kenntnis der Fische Perus, II (Hans-Wilhelm Koepcke), *review* by Dr F A Turk, 1177
Nephrectomy Disappearance of the Erythropoietic Factor from Plasma of Anaemic Dogs after (Dr Jean-Pierre Naets), 371
Nerve Effects of Irradiation of, on Muscular Response (A Portela, D Brandes, Prof G H Bourne, Marion Hines, P Stewart and B L Redd, jun), 734
Nerve Action Potentials Amplitude-Modulation Radio-Telemetry of (Roger M Morrell), 1129
Nerve Axoplasm Action of Ribonuclease on, as Demonstrated by Silver Staining (R K Winkelmann and Robert W Schmit), 553
Nerve Cells in the Ferret Pituitary Gland A Nucleus of (Dr R L Holmes), 1819
Nerve Cells (Frog) Resting and Action Potentials of Reversed Polarity in (Dr I Tasaki), 1574
Nerve Cells (Isolated, Fresh), and Glial Cells from Control and Stimulated Animals Quantitative Assay of Compounds in (Prof Holger Hydén), 433
Nerve Cells (Purkinje), of some Mammals Sex Chromatin ('Chromoleme') in the (Nylceo Marques de Castro and Wilson da Silva Sasso), 293
Nerve Fibres (Mucosal) Are, Essential for the Peristaltic Reflex? (Dr K H Ginzel), 1235
Nerve (Muscle and), in Sodium-free Hydrazinium Solution Excitability and Phosphorylation of (L G Abood and K Koketsu), 725
Nervous Action The Discrete and the Diffuse in (James Arthur Lecture on the Evolution of the Human Brain), (Prof D P C Lloyd), 1777
Nervous System A Biochemist's Guide to the, *review* by Dr G B Ansell, 1261
Nervous System (Central) Biochemistry and the (Prof Henry McIlwain), second edition, *review* by Dr G B Ansell, 1261
Nervous System (Central), of the Carp *Glaucoma* Species in the (Prof A Stolk), 1737
Nestor (Neutron Source Thermal Reactor) to be purchased by the United Kingdom Atomic Energy Authority from the Hawker Siddeley Nuclear Power Co 1533
Netherlands Molluscan Fauna of the, 1612
Netherlands Malacological Society Twenty-fifth Anniversary, 1612
Netherlands New Guinea The Animal World of (Dr L D Brongersma), *review* by J E Hill, 1261
  Fauna of, *review* by J E Hill, 1261
Netherlands–Norwegian Joint Establishment for Nuclear Energy Research Seventh Annual Report (1957-58), 1278
Netherthorpe Lord Appointed a member of the Agricultural Research Council, 508
Network Theory (Modern), in Electrical Engineering (University of Birmingham Conference on), 1691
Networks Synthesis of Linear Communication (Wilhelm Cauer), second edition edited by Wilhelm Klein and Franz M Pelz (translated from the German by G E Knausenberger), *review*, 1525
Networks (Hydrological) Design of (Max A Kohler), (World Meteorological Organization, Technical Note No 25), 96, *erratum*, 684
Neuberger, Prof A , and Klyne, Dr W Steric Aspects of the Chemistry and Biochemistry of Natural Products, 947
Neuhaus, Prof A Twinning of Crystals (Twinning of Diamond), 1911
Neuhaus, F C , and others Teichoic Acids from Bacterial Walls—Composition of Teichoic Acids from a Number of Bacterial Walls, 247
Neuraminic Acid Some Observations on certain Mucoproteins containing (Dr S A Barker, Prof M Stacey, D J Tipper and J H Kirkham), B A 68
Neurofibrillae of the Locust, *Schistocerca gregaria* Effect of Insecticides on the Bodies of Nissl and (Dr Tohamy A Moussa and M Banhawy), 915
Neurohypophysial Extracts from Cold-blooded Vertebrates Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in (Active Principles for the Neurohypophysis of Cold-blooded Vertebrates), (Wilbur H Sawyer, Robert A Munsick and Prof H B. van Dyke), 1464
Neurohypophysis of Cold-blooded Vertebrates Active Principles of the—Chromatographic and Biological Characteristics of Fish and Frog Neurohypophysial Extracts (B T Pickering and Prof H Heller), 1463 ; Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464 , Arginine Vasotocin (Panayotis G Katsoyannis and Prof Vincent du Vigneaud), 1465
Neurohypophysis of certain Vertebrates Natriferin, a New Hormonal Principle in the (J Maetz, F Morel and B Lahlouh), 1236
Neuromuscular Blocking Action of some Antibiotics (G Bezzi and G L Gessa), 905
Neuromuscular Blocking Agents Effect of some, on Mitochondrial Enzyme Systems (Dr J H Koch and Dr C H Gallagher), 1039
Neuromuscular Junction (Mammalian) Post-activation Changes at the (J I Hubbard), 1945
Neurospora A Biological Clock in (Growth Patterns in *Neurospora*), (C S Pittendrigh, Dr V G Bruce, N S Rosenweig and M L Rubin), 169
  Genetic Control of a Cyclic Growth Pattern in (Growth Patterns in *Neurospora*), (Dr D R Stadler), 170
  Growth Patterns in—A Biological Clock in *Neurospora* (C S Pittendrigh, Dr V G Bruce, N S Rosensweig and M L Rubin), 169 , Genetic Control of a Cyclic Growth Pattern in *Neurospora* (Dr D R Stadler), 170
Neurosurgery, Vol 1 (Surgery in World War II), (Colonel John Boyd Coates, editor-in-chief), *review* by J E A O'Connell, 1676
Neurosurgery (U S Army), in the Second World War, *review* by J E A O'Connell, 1676
Neutral Atomic Hydrogen in Globular Clusters A Search for (Dr Morton S Roberts), 1555
Neutral Citrate-Dithionite Reagent Aluminium extracted by (W M H Saunders), 2037
Neutralization of Bridge Blood Anticoagulant (Dr F Nour-Eldin), 1419
Neutron (Electron, Proton and) A Comparison of the Charges of the (A M Hillas and T E Cranshaw), 892
  A Comparison of the Charges on the (Prof H Bondi and Dr R A Lyttelton), 974
Neutron-activated Sections Distribution of Sodium in Compact Bone, as revealed by Autoradiography of (Prof J Vincent), 1332
Neutron Activation Analysis Determination of Chlorine in Muscle Tissues by (Dr Jonas Bergstrom), 1504
Neutron Chain Reactors The Physical Theory of (Alvin M Weinberg and Eugene P Wigner), *review* by Dr J Walker, 1973
Neutron Source Thermal Reactor (*Nestor*) to be purchased by the United Kingdom Atomic Energy Authority from the Hawker Siddeley Nuclear Power Co , 1533
Neveu, T , and others Promoting Effect of Urea on the *in vitro* Passive Sensitization of Isolated Plain Muscles with Precipitating Antibody, 1805
New to Norway *Patella aspera* Lamarck (Knut Kolstad), 1886
New Alloy for Gunmetal (Mond Nickel Co , Ltd), 1025
New Amino-Acid from *Citrullus vulgaris* (Water Melon) α-Amino-β-(pyrazolyl-N) Propionic Acid, a (Dr F F Noe and Dr L Fowden), B A 69
New Analgesic Identification of Phenazocine, a Potent (Dr E G C Clarke), 451
New Antiadrenergic Compounds (A L A Boura, F C Copp and A F Green), B A 70
New Antibiotic Monamycin, a (Prof C H Hassall and K E Magnus), 1223
New Antimetabolites from Vitamin B_{12} (G M Timmis and Dr S S Epstein), 1383
New Approach to Carbon Gasification (J D Blackwood and F K McTaggart), 447
New Approach to the Dating of the Dead Sea Scrolls (Prof D Burton, J B Poole and Dr R Reed), 533
New Approach to Immunity, *review* by Dr J H Humphrey, 753
New Approach to the Mechanism of Mutations (Prof Paul Mandel and Pierre Chambon), 1501
New Approach to Schizophrenia (Dr Julius I Steinfeld), *review* by Prof Martin Roth, 487
New Australian Botanical Laboratory, 1776
New Blood Group Antigen Js^a among South American Indians Frequency of the (Dr Miguel Layrisse and Dr Zulay de Layrisse), 640
New Brain-Stem Stimulants N-Substituted 7-Methoxy-8-Aminomethylchromones and Flavones— (P Da Re, L Verlicchi, Dr I Setnikar, W Murmann and M J Magistretti), 362
New Carbonyl Compound from *Piper methysticum* Forst (Prof Paul J Scheuer and Thomas J Horigan), 979
New Cell Types in the Salivary Glands of the Brown Ear Tick, *Rhipicephalus appendiculatus* Neumann (Dr W M Till), 1078
New Compound from *Olea europaea* Oleuropeic Acid, a (Baruch Shasha and Prof Jeshaia Leibowitz), 2019
New Crystalline Salt of Oxytocin (Dr Miklos Bodanszky and Prof Vincent du Vigneaud), 981, *erratum*, 1777
New Detectors The Importance of, *review*, 1260
New Developments in Training—Five Studies in the Efficient Communication of Skills (edited by Frank A Heller), 421
New Engineering Materials and Design Conference on, 1362
New Enzyme System in the Tamarind (D Mukherjee and N A Khan), 1140
New Experimental Test of Special Relativity (J P Cedarholm and Prof C H Townes), 1350
New Fast Abnormal Haemoglobin in Newborn Nigerians (Dr A E Boyo and R G Hendrickse), 997
New Floristic Studies, 409

New Forensic Science Society, 1271
New Fossil Penguin from Australia (G G Simpson), 1613
New Fossil Skull from Olduvai (Dr L S B Leakey), 491
New Geological Documentation Service, 153
New Geophysical Observatory in Belgium, 1022
New Group of Bacteria *Fasciculus limpidus* nov gen , nov spec , a Representative of a (Prof E G Pringsheim), 1098
New Guinea (Netherlands) The Animal World of (Dr L D Brongersma), *review* by J E Hill, 1261
  Fauna of, *review* by J E Hill, 1261
New Habit among Greenfinches Diffusion of a (Dr Max Pettersson), 649
New Hormonal Principle in the Neurohypophysis of certain Vertebrates Natriferin, a (J Maetz, F Morel and B Lahlouh), 1236
'New' Human Blood Group Antigen, Sw$_a$ (T E Cleghorn), 1324
New Ideas for Industry, *review* by Prof A J Brown, 1348
New Inhibitor of Serotonin Metabolism (Dr Alfred R Maass and Mary Jane Nimmo), 547
New Introduction to Geology, *review* by Dr J C M Taylor, 1175
New Journal of Glass Technology, 855
New Journal of Psychopharmacology, 940
New Maize Virus Needle Transmission of a (Dr I Harpaz), B A 77
New Marine Biological Station on Heligoland (Dr J N Carruthers), 400
New Medical-Surgical Building of the Ontario Veterinary College, 695
New Method for Studying the Functioning of the Lungs (Helge Colldahl, T Alväger and J Uhler), 372
New Method for Working up Processing Mixtures containing Anhydrous Aluminium Chloride (Dr T Széll and A Furka), 117, *erratum*, 595
New Microwave Harmonic Generator (Dr K D Froome), 808
New Multi-range Voltmeter, 'Taylormeter Model 100A', (Taylor Electrical Instruments, Ltd), 1026
New Neotropical Element (*Anoplotermes*) in Indian Termite Fauna (Dr M L Roonwal and O B Chhotani), 1967
New Nitride Precipitate in Iron-Silicon Alloys (G R Booker and J Norbury), 1311
New Nitrogen-fixing Bacterium (H L Jensen, P K De and Roma Bhattacharya), 1743
New Pests of Cocoa (*Theobroma cacao* L) in Ghana following Applications of Insecticides (P F Entwistle, C G Johnson and E Dunn), 2040
New Radioisotope Training Programme (United States Atomic Energy Commission), 771
New Research and Production Facilities of Ciba (A R L) Ltd (R F Webb), 601
New Research Laboratories for the Cambridge Instrument Company, Ltd (Dr M C Marsh), 1364
New Scientific Term Retentate, a (E G Turner and J G Feinberg), 1139
New Service for Naturalists (R S R Fitter), 1774
New Specific Bacteriophages for Plant Pathogenic *Xanthomonas* spp Some (Z Klement), 1248
New Subjective Phenomena apparently due to Interocular Transfer Some (Ian P Howard), 1516
New Technique for Isolating and Cloning Cells of Higher Plants (Ludwig Bergmann), 648
New Techniques in the Analysis of Noise and Vibration (Acoustics Group of the Physical Society and the Institute of Physics Symposium on), 415
New Techniques in High Polymer Chemistry (Bradford Institute of Technology Course in), 1845
New Techniques in Packaging, *review* by Dr V G W Harrison, 1437
New Trichothecin-like Antifungal Antibiotic (E T Glaz, Eszter Scheiber, J Gyimesi, I Horvath, Katalin Steczek, A Szentirmai and G Bohus), 908
New Two-Dimensional Paper Chromatographic Method applied to the Separation of Amino-Acids (C S Knight), 1486
New University (Prof Jack Simmons), *review* by Sir John Wolfenden, 1975
New World Education in the, 81
New York Academy of Sciences Annals, Vol 78, Art 2, The Biology of the Amoeba (Henry I Hirshfield and 22 other authors), 1371
  Annuals, Vol 78, Art 1, Germfree Vertebrates—Present Status (James A Reyniers and 30 other authors), 1541
New York Botanical Garden Resignation of Dr David D Keck as acting director, 680
New York Botanical Garden, and others Fourth International Conference on Plant Growth Regulation, 599
New York University Vacuum Metallurgy—Lectures presented during the Course sponsored by the Department of Metallurgical Engineering in co-operation with the Office of Special Service to Business and Industry, 1957, *review* by Dr F C Thompson, 1765
New Zealand Bionomics of the Brushtailed Opossum *Trichosurus vulpecula* in (R I Kean), 1388
  Forestry in (Sir Harry Champion), 606
  Introduction of Foreign Weeds into (A J Healy), 1361
  Palaeomagnetic Studies of Cenozoic Volcanic Rocks in (Dr D S Coombs and Dr T Hatherton), 883
  Scientific Staff in, 854
New Zealand Antarctic Stations Diurnal Variation of Aurora and Geomagnetic Disturbance at (Dr T Hatherton and G G Midwinter), 889
New Zealand Institute of Architects (New Zealand Master Builders' Federation and the) Establishment of a Building Research Bureau, 235
New Zealand Master Builders' Federation and the New Zealand Institute of Architects Establishment of a Building Research Bureau, 235
New Zealand Research on Weed Transportation 1361
New Zealand Sheep Composition of some Fat-free Carcasses and Bodies of (A H Kirton, M J Ulyatt and R A Barton), 1724
Newborn Nigerians New Fast Abnormal Haemoglobin in (Dr A E Boyo and R G Hendrickse), 997
Newborn Rats and Mice An Improved Technique for Intravenous Injection of (N F Anderson, E J Delorme, Prof M F A Woodruff and D C Simpson), 1952
Newbould, Dr P Availability of Plant Nutrients (Experiments with Calcium-45), 159
Newbould, Dr P , and Lucas, Dr R L Effect of the Level of Microbial Population on Isotopically Exchangeable Phosphate in Soil, 1155
Newcomen Society The Development of Iron and Steel Technology in China (Dr Joseph Needham), (Second Biennial Dickinson Memorial Lecture, 1956), *review* by Prof F C Thompson, 1830
Newell, Prof Norman D Elected to foreign membership of the Geological Society of London, 1360
Newer Developments in the Chemistry of the Non-Metals (Kingston Technical College Course of Lectures on), 1915
Newfoundland Palaeomagnetism and Rotation of (Dr P M Du Bois), B A 63
Newitt, Prof D M Thermodynamics (Phase Changes in Condensed Systems), 1608
Newkirk, G A , and others The Inner Solar Corona during June 1959, 1308
Newman, I A Electrical Determination of Transport of 3-Indole Acetic Acid in *Avena*, 1728
Newman, Prof M H A What is Mathematics ?—New Answers to an Old Question (Presidential Address to the Mathematical Association), 32
Newmark, Philip, and others Macromolecular Components of *Chlorella pyrenoidosa*, 963
Newportia-Arten Kritische Untersuchungen der (Wolfgang Bucherl), (Beiträge zur Neotropischen Fauna), *review* by Dr F A Turk, 1177
Newsom, R M At the Conference of the Mammal Society of the British Isles (Population Fluctuations in the Bank Vole, Field Vole and Wood Mouse), 30
Newspaper Trusts The Work of (Political and Economic Planning, Broadsheet No 435), 1687
Newth, Dr D R Developmental Biology, *review*, 839
Newton, A A , and others Deoxyribonucleic Acid Formation in Multiplying HeLa Cells, 107
Newton, D C , and others Isotopic Composition of Boron, 185
Newton, Isaac Papers and Letters on Natural Philosophy and related Documents (edited with a General Introduction by I Bernard Cohen, assisted by Robert E Schofield), *review* by Dr M A Hoskin, 1750
Newton, L S Relationship between Industry and Technical Colleges, 1690
Newtonian Documents, *review* by Dr M A Hoskin, 1750
Ney, Prof Edward P Photography in the International Geophysical Year (High-altitude Balloon Flights with Nuclear Emulsions), 1032
Ney, Prof Edward P , and Kellogg, Prof Paul J Kellogg and Ney's Model of the Solar Corona, 1122
Ney's (Kellogg and) Model of the Solar Corona (Dr D E Blackwell and Dr D W Dewhirst), 1120 , (Prof Edward P Ney and Prof Paul J Kellogg), 1122
Niblett, G B F Thermonuclear Processes (Rapid Compression of Plasma), 240
  Thermonuclear Research, 1015
  Ionization Phenomena in Gases (Attempts to produce Very Large Rates of Current Growth, by the Design of Very Low Inductance Systems), 1356
Niblett, Prof W R Appointed dean of the University of London Institute of Education with the title of professor of education in the University, 595
Nicholas, D P Awarded a Nature Conservancy Research Studentship for post-graduate training in ecology (botany), 156
Nicholls, C E C Elected president of the Royal Australian Chemical Institute, 1106 , work of, 1106
Nichols, B W (Aylward, Dr Francis, and) Sterol Glycosides in Oilseed Phospholipids, 1319
Nicholson, Dr D C , and others Optical Activity of Stercobilin and *d*-Urobilin, 41
Nickel Company of Canada, Ltd , International Establishment of a Fellowship to honour the visit of H M the Queen and H R H the Duke of Edinburgh, 772
Nickel–Oxygen System 'Thermal Regeneration' in the (Prof J S Anderson and D F Klemperer), 899
Nickell, L G , and others Plant Growth Regulation (Isolation of a New Acid from Coconut Milk), 600
Nicol, Dr D S H W Clinical Biochemical Method, *review*, 576
Nicol, L W (Creeth, J M , and) Structure and Chemistry of Proteins (Urease), 1277
Nicol, Prof T , and Sewell, I A Effect of Sulphonamides on the Phagocytic Activity of the Reticulo-Endothelial System, 1241
Nicolau, Prof C T , and others Loss of Plasticity of Erythrocytes coated with Incomplete Antibodies, 1808
Nicotinamidase in *Mycobacteria*—a Method for Distinguishing Bovine Type Tubercle Bacilli from other *Mycobacteria* (Dr Kiyoshi Konno, Dr Hideo Nagayama and Dr Sutemi Oka), 1743
Nicotinamide Synthesis of Diphosphopyridine Nucleotide from, by Slices of Liver (C J Threlfall), 60
Nicotinamide Analogues and Precursors Reversal of Effects of 2-Substituted Thiadiazoles by (Dr Irwin H Krakoff, Corrine R Lacon and Dr David A Karnofsky), 1805
Niederpruem, Dr D J , and Hackett, Dr D P Cytochrome System of *Streptomyces*, 1954
Nielsen, Prof E Steemann Polar Front Survey (Biology—Carbon-14 Measurements and Chlorophyll Measurements in the North Atlantic and in the Greenland Sea), 1183
Nielsen, Dr Eric T Copulation of *Glyptotendipes* (*Phytotendipes*) *paripes* Edwards, 1252
Niesters, H Ionization Phenomena in Gases (Breakdown Potential Measurements below the Paschen Minimum), 1354
Nigeria, International Commission on Higher Education in Inaugural Meeting, 152
Nigeria (Western) Stone Implements from (E L Kostick, C N Williams and S A Williams), 124
Nigerian College of Arts, Science and Technology Grants to the, 1985
Nigerian Rain-Forest Zone Non-Symbiotic Nitrogen Fixation in a Soil of the (Dr A W Moore and J N Abaelu), 75
Nigerians (Newborn) New Fast Abnormal Haemoglobin in (Dr A E Boyo and R G Hendrickse), 997
Night Interruption with Red Light Complex Reaction in *Hyoscyamus niger* upon (P J A L de Lint), 731
Night Sky in October, 508 , in November, 772 , in December, 1451 in January, 1915
Nikaido, Hiroshi (Fukasawa, Toshio, and) Galactose-sensitive Mutants *Salmonella*, 1168
Nikuni, Ziro (Mishina, Akira, and) Physical and Chromatograph Observations of γ-Irradiated Potato Starch Granules, 1867

Nile Valley Effects of the Water Hyacinth (*Eichornia crassipes*), in the (H R J Davies), 1085
Nile (West) Virus Duration of Protective Action of Interferon against Infection with (Dr Alick Isaacs and Marguerite A Westwood), 1232
Nimmo, Mary Jane (Maass, Dr Alfred R , and) A New Inhibitor of Serotonin Metabolism, 547
Nimrod (7,000-MeV Proton Synchrotron) Contracts for work on the (National Institute for Research in Nuclear Science), B A 14
Nirk, Helgi Interspecific Hybrids of *Lycopersicum*, 1819
Nishibori, Kokichi Isolation of Echinochrome A from the Spines of the Sea Urchin, *Diadema setosum* (Leske), 1234
Nissan, Prof Alfred H , and Higgins, H G A Molecular Approach to the Problem of Viscoelasticity, 1477
Nitrate Reductase Isolation and Purification of, from Embryos of Germinating Wheat (D Spencer), 682
Nitrate Reduction by Aqueous Extracts of Excised Tomato Roots (C S Vaidyanathan and Prof H E Street), 531
Nitration of Hydrocarbons and other Organic Compounds (A V Topchiev) translated from the Russian by Catherine Matthews, *review* by Prof M J S Dewar, 577
Nitride (Boron Phosphide and) Synthesis of (Dr R C Vickery), 268
Nitride (Cubic Boron) Transformation of a, to a Graphitic Form of Hexagonal Boron Nitride (H Judith Milledge, E Nave and F H Weller), 715
Nitride (Hexagonal Boron) Transformation of a Cubic Boron Nitride to a Graphitic Form of (H Judith Milledge, E Nave and F H Weller), 715
Nitride Precipitate (A New), in Iron-Silicon Alloys (G R Booker and J Norbury), 1311
Nitriding (Carbo-) Identification of the High-Temperature Constituent in Mild Steel Surface-Hardened by (M A H Howes, G T F Jay, K Sachs and D Wilkinson), 1312
Nitrite Estimation by Diazotization Measurement of Inhibition by Azide in Biochemical Assay Systems involving (Dr E J Hewitt and D G Hallas), 1485
Nitro Groups Quantitative Paper Chromatography based on the Sub-Micro Titration of Derivatives containing (L Blom and J Caris) 1313
Nitrogen Fixation of, by the Rice Plant (S P Chakraborty and S P Sen Gupta), 2033
  Near Infra-Red System of (Dr P K Carroll and Dr H E Rubalcava), 119
Nitrogen Assimilation of *Vicia villosa* Influence of Gibberellic Acid and Photoperiod on the Growth, Flowering, Nodulation and (the late Prof Margaretha G Mes), 2035
Nitrogen Compounds Six-Membered Heterocyclic, with Three Condensed Rings (C F H Allen, in collaboration with G M Badger, Brice Graham, G A Reynolds, James H Richmond John R Thirtle, J A Van Allen and C V Wilson), *review* by Dr F G Mann, 216
Nitrogen Content of Rain Water collected in the Humid Central Congo Basin (J Meyer and E Pampfer), 717
Nitrogen Fixation in a Uganda Swamp Soil (E A Calder), 746
Nitrogen Fixation (Non-Symbiotic), in a Soil of the Nigerian Rain-Forest Zone (Dr A W Moore and J N Abaelu), 75
Nitrogen Fixation (Symbiotic), of Legumes Influence of Temperature on the (the late Prof Margaretha G Mes), 2032
Nitrogen-fixing Bacterium A New (H L Jensen, P K De and Roma Bhattacharya), 1743
Nitrogen Replenishment in the Soil (Dr N R Dhar), 942
Nitrogenous Material (Air-borne), and other Plant Nutrients Surface of the Ocean as a Source of (Dr A T Wilson), 99
p-Nitrophenyl Acetate Catalysed by Chymotrypsin Reactivity and Interrelationship of Intermediates in the Hydrolysis of (Mario A Marini and Prof George P Hess), 113
Nitrous Acid Effect of, on Tobacco Mosaic Virus—Mutation or Selection? (F C Bawden), B A 27
Nitzsche, S Macromolecules (Inorganic and Organic/Inorganic Polymers), 1690
Nixon, D A Inositol Concentration in the Cerebrospinal and Ocular Fluids and Tissues of the Foetal and Adult Sheep, 906
Njoku, Dr E Appointed professor of botany at University College, Ibadan, 26
Noakes, G R Basic Electricity, *review*, 133
  Microcosm to Macrocosm, *review*, 214
  Turning Points in Physics, *review*, 1090
Nobbs, J M At the Second Australian Spectroscopy Conference (Emission Spectroscopy—Some Effects of Pulse Shape on the Spectral Characteristics of Pulsed Discharges), 1197
Nobel Prize for Chemistry for 1959 awarded to Prof Jaroslav Heyrovsky, 1271
Nobel Prize for Medicine for 1959 divided between Prof S Ochoa and Prof A Kornberg, 1021
Nobel Prize for Physics for 1959 awarded to Dr Emilio Segre and Dr Owen Chamberlain, 1189
Nobelium Research on (P R Fields *et al*), 507
Nockolds, Dr S R Principles of Geochemistry, *review*, 1601
  Geochemical Research in the United States, *review*, 1757
Noctilucent Clouds Polarization of Light from (Georg Witt), 1618
Noctuidae (Adult) (Lepidoptera), in Cambodia Blood-feeding Habits of (W Buttiker), 1167
Nocturnal Conditions (Diurnal and) Changes in the Lacunal Parenchyma of *Mimosa pudica* in (Hideo Toriyama), 737
Nodes (Single), of Ranvier in Potassium-rich Solutions Action Potentials from (Dr Hans-Christoph Luttgau), 1494
Nodulation of Legumes Gibberellic Acid and (Dr Wm W Fletcher, J W S Alcorn and J C Raymond), 1576
Nodulation and Nitrogen Assimilation of *Vicia villosa* Influence of Gibberellic Acid and Photoperiod on the Growth, Flowering, (the late Prof Margaretha G Mes), 2035
Nodules formed by the Grain Boundary Reaction in Aluminium–Zinc Alloys Reversion of (Ryoji Watanabe and Shigeyasu Koda), 977
Nodules (Soybean), during the Vegetative Period Redox Potentials in (Dr Helene Ebertova), 1046
Noe, Dr F F and Fowden, Dr L α-Amino-β-(pyrazolyl-N) Propionic Acid, a New Amino-Acid from *Citrullus vulgaris* (Water Melon), B A 69
Noguchi, I (Hattori, Dr S , and) Microbial Degradation of Rutin, 1145
Nogueira, Otilia C , and others Methaemoglobin Reduction through Cytochrome B_5, 1651
Noise Current Research on (Derwent M A Mercer), 414
  Distribution of Flares on the Solar Disk Associated with (L R McNarry), 806
Noise (Jet Aircraft) Effect of, on Hearing (Surg Lieut R R A Coles and J J Knight), 1803
Noise (Low-Frequency (100 kc /s) Radio), from the Aurora (R L Dowden), 803
Noise (Radio), from the Outer Atmosphere Directional Observations of (G R A Ellis and D G Cartwright), 1307
  Spaced Observations of (G R A Ellis, D G Cartwright and J R V Groves), 1391
Noise Problems Recent Studies of (Acoustics Group of the Physical Society Symposium on), 414
Noise and Vibration New Techniques in the Analysis of (Acoustics Group of the Physical Society and the Institute of Physics Symposium on) 415
Noise (Cosmic), at Low Frequencies above the Ionosphere Measurement of (J P I Tyas, C A Franklin and A R Molozzi), 785
Noise (Radio) Effect of Atomic Tests on (C A Samson), 538
Nolan, B , and others Excretion of Labelled Magnesium by the Sheep, 736
Nomenclature in Titrimetric Analysis (Committee of the Analytical Chemistry Section of the International Union of Pure and Applied Chemistry), 1686
Nomenclature (Zoological), International Commission on Given accommodation in the British Museum (Natural History), 156
Non-Cartridge Type Demineralized Water Units, 25
Non-Destructive Testing International Conference on, 1107
Non-Diabetic Humans of Varying Ages Actual Distribution of the Number and Volume of the Islets of Langerhans in Different Size Classes in (Bo Hellman), 1498
Non-Dialysable Inhibitor of Glutamo-Transferase present in Excised Tomato Roots (C S Vaidyanathan and Prof H E Street), 347
Non-Enzymic Macromolecules Reaction-directing Properties of—Pyrogallol Oxidation in the System Iron (III)–Cellulose (N S Goodman and S M Siegel), 53
Non-Esterified Fatty Acids Release of, from Adipose Tissue in Normal and Diabetic Rats (Dr J Wendeová and Dr J Pav), 1147
Non-Ferrous Metals Research Association (British) New Research Laboratories, 234, 242
  Election of F C Braby as chairman of the Council 1273
Non-Gummy Chromogenic Strain of *Azotobacter vinelandii* (J A Bush and Prof P W Wilson), 381
Nonhaem Iron in Erythrocytes as a Precursor for Haemoglobin (Dr M Faber and Dr I Falbe-Hansen), 1043
Non-Inverted versus Inverted Plots in Enzyme Kinetics (Dr B H J Hofstee), 1296 , (Dr Malcolm Dixon and Dr Edwin C Webb), 1298
Non-Leguminous Plant, *Hyptis suaveolens* Poit Anti-A Haemagglutinins from a (Dr G W G Bird), 109
Non-linear Clocks Stochastic Rectification of (David G Kendall), 1476
Non-Linear (Linear and), Structural Relations Estimation of (D E Barton and C L Mallows), 1086
Non-Metals Newer Developments in the Chemistry of the (Kingston Technical College Course of Lectures on), 1915
Non-Oxide Glasses (Bell Telephone Laboratories), 594
Non-Pathogenic Fungi (Pathogenic and) Human Precipitins against Common (Dr J Pepys, Dr R W Riddell and Dr Y M Clayton), 1328
Non-Photosynthetic Bacteria Function of Carotenoid Pigments in (Micheline M Mathews and W R Sistrom), 1892
Non-Ruminants Trans-Unsaturated Acids in the Depot Fats of Ruminants and (L Hartman and Dr F B. Shorland), 2024
Non-Symbiotic Nitrogen Fixation in a Soil of the Nigerian Rain-Forest Zone (Dr A W Moore and J N Abaelu), 75
Nonweiler, T R F , and others Jets and Rockets, *review* by D G King-Hele, 1346
Noradrenaline Response of Cholinergically Innervated Sweat Glands to Adrenaline and (Dr David P C Lloyd), 277
Noradrenaline from Adrenaline Formation of, by Rat Liver Mitochondria (Dr Kunio Yagi and Dr Toshiharu Nagatsu), 1316
Noradrenaline and Adrenaline in the Rat Brain during Acute and Chronic Morphine Administration and during Withdrawal (Dr Lars-M Gunne), 1950
Norbury, J (Booker, G R , and) A New Nitride Precipitate in Iron-Silicon Alloys, 1311
Norepinephrine Evidence of Side-Chain Cleavage during the Reaction of Epinephrine and, with Ethylene Diamine (Dr Louis-P Joly and Dr Guy Nadeau), 1483
Norinder, H Ionization Phenomena in Gases (Relation between Lightning Discharges and Whistlers), 1355
Normal American Population An Association between Abo Blood Groups and Fertility in a (Dr T Edward Reed and Dr J H Ahronheim), 611
Normal Human Serum Influence of Coagulase on the Growth of Staphylococci in (Dr K Wlodarczek and Dr J Jeljaszewicz), 1514
Normal Metabolism of Strontium-90 in Rats Attempts to Modify the (Dr V Volf), 1401
Normal Soluble Proteins in Guinea Pig Liver Agar Electrophoresis of (Prof Iv Goranov, Y Todorov, X Skatshokova, M Hlebarova and P Kuzmanova), B A 64
Normal and Adrenalectomized Mice Effect of Diet on the Blood Sugar and Liver Glycogen Level of (B P Block and Dr G S Cox), 721
Normal and Cancer Cells Localization of β-Glucuronidase in (J Conchie and Dr G A Levvy), 1709
Normal and Diabetic Rats Release of Non-Esterified Fatty Acids from Adipose Tissue in (Dr E Wendeova and Dr J Pav), 1147
Normal and Primaquine-sensitive Erythrocytes Characteristics of Glucose-6-phosphate Dehydrogenase from (Glucose-6-phosphate Dehydrogenase and Human Erythrocytes), (Dr Henry N Kirkman), 1291
Norris, Dr R E (Womersley, Dr H B S , and) A Free-Floating Marine Red Alga, 828
Norrish, Prof R G W (Callear, Dr A B , and) Mechanism of Anti-Knock, 1794

North–South Anisotropy and Anticipatory Increase of Intensity associated with the Cosmic-Ray Storm of February 11, 1958 (Dr V Sarabhai and R Palmeira), 1204
North America The Evolution of (Dr Philip B King), *review* by Dr J W Cowie, 1600
  The Geological Development of, *review* by Dr J W Cowie, 1600
  The Mammals of (Prof E Raymond Hall and Dr Keith R Kelson), *review* by Peter Crowcroft, 1524
North America (Arctic) The Benthos of Soft Sea-bottom in (Dr D V Ellis), B A 79
North American Mammals, *review* by Peter Crowcroft, 1524
North Atlantic Ocean Polar Front Survey in the, 1180
North Kenya Banks (Dr J F C Morgans), 259
North-West Scotland Rubidium-Strontium Ages of Lewisian Rocks from (Dr Bruno J Giletti), 1793
Northern Ireland (Great Britain and) Statistics of Public (Rate Supported) Libraries in, 1957-58 (Library Association), 592
Norton, Dr William T Reaction of Mercuric Chloride with Plasmalogen, 1144
Norway *Patella aspera* Lamarck, New to (Knut Kolstad), 1886
Norwegian Institutt for Atomenergi The Halden Reactor, 516, 1844
Norwegian Sparagmites and the Late Pre-Cambrian Ice Age Palaeomagnetism in some (W B Harland and D E T Bidgood), 1860
Norwood Technical College, London Course of lectures and practical work on Micro- and Semi-microchemical methods, 1845
Notes for Authors (Institute of Physics), revised edition, 95
Notton, B M, and others Alkali Ion Determinations by means of Glass Electrodes (Tests on Experimental Electrodes of Aluminosilicate Glasses), 1617
Nour-Eldin, Dr F Neutralization of Bridge Blood Anticoagulant, 1419
Novak, Dr L (Pospisil, Dr M, and) Importance of the Type of Metabolism for the Radiosensitivity of Mice, 1814
Novelli, G D (Bernlohr, Robert W, and) Antibiotic Production as a Function of Spore Formation in *Bacillus licheniformis*, 1256
Noyes, R M Fast Chemical Reactions in Solution (Solution Structure and Fast Reactions), 1454
NTC Resistors Intravascular and Intracardiac Blood Velocity Patterns recorded by means of (Dr W G Zijlstra, J R Brunsting and L B v d Slikke), 991
Nuclear Data (European–American) Committee for (European Nuclear Energy Agency), 1271
Nuclear Deoxyribonucleic Acid Content and Endopolyploidy in the Meristem of Onion Roots (D Srinivasachar), B A 80
Nuclear Energy Post-Graduate Training in the Public Health Aspects of (World Health Organization, Technical Report Series No 154), 33
  Progress in, Series 6, Biological Sciences, Vol 2, (edited by J G Bugher, J Coursaget and J F Loutit), *review* by Prof G Pontecorvo, 1902
  Progress in, Series 7, Medical Sciences, Vol 2 (edited by J C Bugher, J Coursaget and J F Loutit), *review* by Dr N M Blackett, 1766
Nuclear Energy and Analysis, *review* by G W C Milner, 1524
Nuclear Energy and Medicine, *review* by Dr N M Blackett, 1766
Nuclear Energy Agency (European) of the Organization for European Economic Co-operation Formation of a Committee for European—American Nuclear Data, 1271
  Second Fuel Charge for the Boiling Heavy Water Reactor Project at Halden, Norway, 1844
Nuclear Energy Conference, British (Institution of Electrical Engineers and the) Convention on Thermonuclear Processes, 240
Nuclear Energy Project (European), *Dragon*, 24, 942
Nuclear Energy Research European, 1278
Nuclear Energy Research, Netherlands–Norwegian Joint Establishment for Seventh Annual Report (1957-58), 1278
Nuclear Explosion (Johnston Island) Disturbance in the Ionospheric *F*-Region following the (C H Cummack and G A M King), B A 32
Nuclear Explosions Geomagnetic and Ionospheric Phenomena associated with (Dr S Matsushita), B A 33
  Some Geomagnetic Phenomena associated with (Dr R G Mason and Dr M J Vitousek), B A 52
  Geophysical Effects of High-Altitude (W A Feibelman), 442
  Magnetic Effects resulting from Two High-Altitude (J A Lawrie, V B Gerard and P J Gill), B A 34
Nuclear Forces and the Few-Nucleon Problem International Conference on (Dr T C Griffith and E A Power), 1113
Nuclear Fuel Treatment, *review* by Dr J E Littlechild, 1346
Nuclear Fuels Chemical Processing of (Dr F S Martin and Dr G L Miles), *review* by Dr J E Littlechild, 1346
Nuclear Installations (Licensing and Insurance) Bill Third reading in the House of Commons, 680
Nuclear Physics at the University of the Witwatersrand, 233
Nuclear Physics, Development Commission on Biological (Non-Medical) Problems of (Agricultural Research Council, the Medical Research Council and the) Appointment of Sir James Denby Roberts as chairman of the Joint Committee of the, 237
Nuclear Power Development of, *review* by R Brightman, 1673
  The Economics of, including Administration and Law (edited by I R Maxwell, P W Mummery and Philip Sporn), Vol 2, *review* by R Brightman, 1673
  Prospects for (Political and Economic Planning, Broadsheet No 431), 383
Nuclear Power and its Development, 383
Nuclear Power (Civic) Research and Development Charges in, 406
Nuclear Power Station The Japanese, 407
Nuclear Power Stations in Britain National Parks and, 1005
Nuclear-Powered Ship, *Savannah* (F D Robinson), 677
Nuclear Reaction Technology Analytical Chemistry in (Third Conference on), 26
Nuclear Reactions in Cosmical Electrical Discharges The Temperature required for (Dr C E R Bruce), 2004
Nuclear Reactor *RB* Accident in Yugoslavia, 406
Nuclear Reactors Directory of (International Atomic Energy Agency), Vol 1, Power Reactors, *review* by Dr A J Salmon, 1438
Nuclear Reactors for Power Generation (edited by E Openshaw Taylor), *review* by R Vaux, 301
Nuclear Research in Australia, 1118
Nuclear Research, European Organization for (CERN) Present Status, 944
  International Co-operation in the field of High-Energy Accelerators, 1844
  Election of Officers, 1844
Nuclear Research Foundation (Australian) Third Summer School for Science Teachers, 1108
Nuclear Science, National Institute for Research in Contracts for work on the 7,000-MeV Proton Synchrotron *Nimrod*, B A 14
Nuclear Structure of Growing Naked Protoplasts of Yeasts (Dr O Nečas) 1664
Nuclear Studies (Science Department of the British Council third list of), 235
Nuclear Technology and the Scholarly Tradition, *review* by Dr J Walker 1973
Nuclear Weapon Tests and the Accident at Windscale Accumulation of Radioactive Iodine in Thyroid Glands subsequent to (Dr Hamish A Robertson and Ian R Falconer), 1699
Nuclear Weapons Debris Fractionation Phenomena in (K Edvarson, Kerstin Low and J Sisefsky), 1771
Nuclease Activity of Bean (*Phaseolus vulgaris*) Hypocotyls Influence of Kinetin, β-Indoleacetic Acid and Gibberellic Acid on (Dr W Maciejewska-Potapczyk), 557
Nuclei of Calf Thymus High Molecular Weight Ribonucleic Acids from the (Dr Ping-yao Cheng), 190
Nuclei (Isolated) Transplantation Immunity—Separation of Antigenic Components from (André Castermans and André Oth), 1224
Nuclei (Isolated Thymus) Monovalent Cations and the Incorporation of Metabolites by (Dr Theodore R Breitman and Dr George C Webster), 637
Nuclei (Tegmental) A Heat-Loss Mechanism involving the Habenular, Interpeduncular and Dorsal (B G Cragg), 1724
Nucleic Acid and a Cationic Detergent Interaction between (Prof Dino Guerritore and Luciano Bellelli), 1638
Nucleic Acid (Infectious) Recovery of, from Tobacco Mosaic Virus inactivated by Antibody (Dr Irving Rappaport), 1732
Nucleic Acid and Protein Synthesis in *Mycobacterium smegmatis* Effect of Iron and Zinc on (Frank Winder and Joan M Denneny), 742
Nucleic Acids Distribution of, among Different Stable *L* Forms of *Proteus P 18* (Prof P Mandel, A Sensenbrenner, P De Gregario and A M Bader), 566
Nucleon Mass and Electron Mass Ratio of (Prof A J Rutgers), 894
Nucleopeptides (Cytoplasmic), in Guinea Pig Liver (P Szafranski, E Sulkowski and T Golaszewski), 1940
Nucleoprotein Particles (Turnip Yellow Mosaic Virus), with Differing Biological and Physical Properties (R E F Matthews), 530
Nucleotide (Diphosphopyridine) Effect of Reduced on the Swelling of Isolated Mitochondria (Dr G Di Sabato), *erratum*, 95
Nucleotide (Diphosphopyridine), from Nicotinamide Synthesis of, by Slices of Liver (C J Threlfall), 60
Nucleotide (Pyridine) Fluoresence Measurements of Mitochondrial, in Aerobiosis and Anaerobiosis (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Prof Britton Chance and Dr Bo Thorell), 931
Nucleotide-linked Cystine Reductase (Triphosphopyridine) A Reduced, in the Clothes Moth, *Tineola bisselliella* (Humm), (R F Powning and H Irzykiewicz), 1230
Nucleotide Oxidase (Pyridine), from Heart Sarcosomes Corticosterone Inhibition of (P K Jensen), 451
Nucleotide Oxidation (Diphosphopyridine) Inhibition of Reduced, by Ammonia (R T Wedding and H M Vines), 1226
Nucleotide–Peptide Compounds of *Saccharomyces cerevisiae* (G Harris and J W Davies), 788
Nucleotides from Yeast Cells Release of (Masataka Higuchi and Prof Teijiro Uemura), 1381
Nucleotides (Purine), of Red Lateral Muscle of Rainbow Trout Changes in (Tsuneyuki Saito, Ken-ichi Arai and Toshikatsu Yajima) 1415
Nucleus of Nerve Cells in the Ferret Pituitary Gland (Dr R L Holmes), 1819
Nucleus (Yolk), in the Oocytes of some Fishes Development of the (Prof A Stolk), 1746
Nuclides (Alpha-Emitting), in Biological Material Spectroscopic Identification of (Prof W V Mayneord and C R Hill), 667
Nuffield Foundation Age and the Working Lives of Men (F Le Gros Clark), 318
  Grant of £8,000 to the University of Oxford, for the continuation of research being carried out by H B Parry at the Nuffield Institute for Medical Research, 1986
Number of Free Radicals in Coal during Carbonization at Different Heating Rates (J Smidt and Prof D W van Krevelen), 719
Number and Volume of the Islets of Langerhans in Different Size Classes in Non-diabetic Humans of Varying Ages Actual Distribution of the (Bo Hellman), 1498
Numbers Some Recent Progress in the Analytic Theory of (Prof H Davenport), 1533
Numbers of People, *review* by Dr B Benjamin, 1521
Numerical Analysis and Partial Differential Equations (George E Forsythe and Paul C Rosenbloom), *review* by Prof T A A Broadbent, 576
Nunn, J F, and others 'Supercarbia' in the Anaesthetized Dog, 1071
Nurse, Dr R W Clay Minerals (Relationship between the Mineralogical Constitution and the Firing Properties of Clays), 779
Nutrients (Plant) Availability of (British Society of Soil Science Discussion on), 159
  Surface of the Ocean as a Source of Air-borne Nitrogenous Material and other (Dr A T Wilson), 99
Nutrition Classics of, *review* by Dr Leslie J Harris, 484
  Embryonic (edited by Dorothea Rudnick), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
  A History of (Prof Elmer Verner McCollum), edited by H Bentley Glass, *review* by Dr Leslie J Harris, 484
Nutrition Meeting in Europe, Rome, 1958 (Food and Agriculture Organization of the United Nations, Report Series No 21), 407
Nutrition Society of Canada Borden Award, 507

Nutrition, Journal of Appointment of Dr Richard H Barnes as editor, 156
Appointment of Dr Cyril L Comar as associate editor, 156
Nutritionally Deficient Mutant of Pathogenic *Fusarium oxysporum* after Ultra-violet Irradiation Production of a Perfect Stage in a (E W Buxton), 1258
Nyasaland Occurrence of Presumed Glossopteridean Fructifications in Rhodesia and (Dr William S Lacey), 1592
Nye, Dr J F Surface Topography of the Antarctic Ice Sheet, 786
Nyns, Ed Jacques (Ålbertsson, Per-Åke, and) Counter-Current Distribution of Proteins in Aqueous Polymer Phase Systems, 1465, *erratum*, 1688
Nystrom, Dr S H M Electron Microscopical Structure of the Wall of Small Blood Vessels in Human Multiform Glioblastoma, 65

OAKLEY, Dr K P (de Vries, Prof H, and) Radiocarbon Dating of the Piltdown Skull and Jaw, 224
Obayashi, Tatsuzo Very Low-Frequency Spectra of Atmospherics propagated through the Ionosphere, 34
Obese-Hyperglycaemic Mice Increased Circulating Insulin-like Activity in (Jean Christophe, Yves Dagenais and Jean Mayer), 61
Objects (Microscopical) Recording the Positions of (Dr J R Baker), 34
O'Brien, B R A 8-Azaguanine Inhibition of Haemoglobin Synthesis in De-embryonated Chick Blastoderm, 376
O'Brien, Dr J R Some Properties of Damaged Endothelial Cells, 1580
Observation Phylogeny of the Genus *Aniba* Aubl —a Comparative Morphological and Chemical (Walter B Mors, Otto Richard Gottlieb and Ida de Vattimo), 1589
Observation (Apparent), of Solar Corpuscular Clouds by Direct Continuous-Wave Reflexion (Dr John D Klaus and W Reed Crone), 965
Observational Technique (Simple) Value of a, for Determining the Fat Content of Algal Cells (Dr J H Evans), 1737
Observations of the Fine Structure of Enhanced Solar Radio Radiation with a Narrow-Band Spectrum Analyser (Oystein Elgaroy), 887
Observations on certain Mucoproteins containing Neuraminic Acid Some (Dr S A Barker, Prof M Stacey, D J Tipper and J H Kirkham), B A 68
Observations of the Russian Moon Rocket *Lunik II* (Dr J G Davies and Prof A C B Lovell), 501, (Patrick Moore), 502, (Dr H Percy Wilkins), 502
Observations of 'Whistlers' and Very Low Frequency Phenomena at Godhavn, Greenland (Eigil Ungstrup), 806
Observations (Directional), of Radio Noise from the Outer Atmosphere (G R A Ellis and D G Cartwright), 1307
Observations (Physical and Chromatographical), of γ-Irradiated Potato Starch Granules (Akira Mishina and Ziro Nikuni), 1867
Observations (Preliminary), on the Fate of Intravenously Administered Lactose Labelled with Carbon-14 (Dr Frederick J Carleton and Dr Henry R Roberts), 1650
Observations (Radiation), with Satellite 1958δ over Australia (Dr A J Herz, Dr K W Ogilvie, J Olley and R B White), 391
Observations (Radio Echo), of Venus (J V Evans and G N Taylor), 1358
Observations (Satellite), of Solar Cosmic Rays (Pamela Rothwell and Carl McIlwain), 138
Observations (Satellite Orbit) Air Density in the Upper Atmosphere from (Dr G V Groves), 178
Observations (Spaced), of Radio Noise from the Outer Atmosphere (G R A Ellis, D G Cartwright and J R V Groves), 1391
Observations (Wear), through Interfacial Micro-Windows (Robert H Savage), 45
Observatories (Colaba and Alibag) Retirement of S L Malurkar from the directorship, 1611
Observatory, United States National Radio Astronomy Appointment of Prof Otto Struve as first director, B A 14
Observatory (New Geophysical), in Belgium, 1022
Observed Quantities A Least-Squares Solution for a Linear Relation between Two (P A Wayman), 77, (B K Kelly), 1086
Occupational Exposure Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and Water for (United States National Bureau of Standards, Handbook 69), 939
Occupational Hygiene Society (British) Eleventh Conference (Heating and Ventilation), 1987
Occurrence of Astaxanthin in the Flower Petals of *Adonis annua* L (A Seybold and Prof T W Goodwin), 1714
Occurrence of Embryo Sac-like Structures in the Microsporangia of *Leptomeria billardierii* R Br (Dr Manasi Ram), 914
Occurrence of 4-Hydroxypipecolic Acid in *Acacia* Species (Dr J W Clark-Lewis and P I Mortimer), 1234
Occurrence of 3-Indolylacetic and 3-Indolecarboxylic Acids in Tomato Crown-Gall Tissue Extracts (G Clarke, M H Dye and Prof R L Wain), 825
Occurrence of Leuco-Anthocyanin in Sour and Sweet Cherries (Dr Kuang C Li), 1935
Occurrence of 4-0-Methyl Glucoronic Acid in *Rhizobium* Gums (Beverley A Humphrey), 1802
Occurrence of Microbiological Filaments in Soils (Roy D Bond), 744
Occurrence of Neoteny in the Genus *Artemia* (Inder Chand Baid), 73
Occurrence of Polynucleotide Phosphorylase in Atypical Epithelioma of Rat (Dr Kunio Yagi, Takayuki Ozawa and Hiroshi Konogi), 1939
Occurrence of Presumed Glossopteridean Fructifications in Rhodesia and Nyasaland (Dr William S Lacey), 1592
Occurrence of *Schoenus nigricans* L on Ombrogenous Peats (D J Bellamy), 1590
Occurrence and Quantitative Determination of 2-Dimethylaminoethanol in Animal Tissue Extracts (Dr Conrad G Honegger and Ruth Honegger), 550, *erratum*, 1986
Ocean Surface of the, as a Source of Air-borne Nitrogenous Material and other Plant Nutrients (Dr A T Wilson), 99
Ocean (Atlantic), and adjacent Waters The Hydromedusae of the (P L Kram[illegible]), (*Dana* Report No 46), *review* by J H Fraser, 300
Ocean (North Atlantic) Polar Front Survey in the, 1180
Ocean (Pacific) Evidence of a South Equatorial Countercurrent in the (Joseph L Reid, jun), 209
Ocean (western Pacific Ocean and eastern Indian) Oceanographic and Geophysical Investigation of the (Scripps Institution of Oceanography), 24
Oceanic Areas (Continental and) Depth of Isostatic Compensation and Mohorovičić Discontinuity, etc, in (J N Nanda), 629
Oceanographic Congress International (Dr G E R Deacon), 1605
Oceanographic Survey of the Ross Sea (J S Bullivant), 422
Oceanography Apparatus and Methods of (Dr H Barnes), Part I, Chemical, *review* by F A J Armstrong, 299
Bedford Institute of 769
Canadian Institute of, 769
Chemical, *review* by F A J Armstrong, 299
Oceanography, Scripps Institution of Oceanographic and Geophysical Investigation of the western Pacific Ocean and the eastern Indian Ocean, 24
Oceans Plants on Land and in the (Dr W R G Atkins), B A 46
Ochoa, Prof S Nobel Prize for Medicine for 1959 divided between Prof A Kornberg and, 1021 work of, 1021
O'Connell J E A U S Army Neurosurgery in the Second World War, *review*, 1676
O'Connor Cecilia M (edited by G E W Wolstenholme and) Ciba Foundation Symposium on Medical Biology and Etruscan Origins, *review* by Madeleine Smith, 1348
Octopus Kingdom of the (Frank W Lane), *review* by Anna M Bidder, 218
Ocular Fluids (Cerebrospinal and), and Tissues of the Foetal and Adult Sheep Inositol Concentration in the (D A Nixon), 906
Odaka, Prof Takeshi, and Watanabe, Tadashi Transformation Reaction of Pneumococci in the Absence of Serum Factor, 471
Odd-Numbered Carbon Fatty Acids from Propionate Production of, by Mice (Prof S B Tove), 1647
Oddie, B C V Potassium/Sodium Ratio in Rainwater, 1791
O'Dea, J F Structure and Chemistry of Proteins (Isolation of the Components of Serum), 1277
Odishaw, Dr Hugh (edited by Dr E U Condon and) Handbook of Physics, *review* by Prof H Lipson and S G Lipson, 298
O'Donnell, I J, and others Structure and Chemistry of Proteins (Soluble Wool Proteins), 1277, (Methods of Splitting Disulphide Bonds and their Application in the Extraction of Soluble Proteins from Wool), 1277
Odontology of *Oreopithecus* A Contribution to the (P M Butler and J R E Mills), 682
O'Dwyer, Dr J J Ergonomics, its Place in Industry, B A 21
Oenothera The Genus, *review* by Dr W B Turrill, 1974
Taxonomy and Genetics of (Prof R Ruggles Gates), *review* by Dr. W B Turrill, 1974
Oertle, Donald H (Radd, Frederick J, and) Strength Impairment Mechanism of Glass in Aqueous Systems, 976
Oesophagus in Decerebrate Sheep Responses to Localized Distension of the (Prof A F Sellers and Dr D A Titchen), 645
Œstradiol The C_{17}-OH Group of—Relationships between its Anti-Atherogenic and Endocrine Actions (Dr Manuel Rene Malinow, Alvaro L Gimeno, Amanda A Pellegrino-Iraldi, Martha A Fernandez-Gimeno, Jorge L Lacuara and Jaime A Moguilevsky), 1720
Œstrogen Seasonal Changes in the Œstrous Response by the Ovariectomized Ewe to Progesterone and (Prof J I Raeside and M F McDonald), 458
Œstrogen in the Ovary of the Rat Site of Production of (Dr Bengt Falck), 1082
Œstrogens in Pasture (J L van Haaften), 1575
Œstrogens (Phenolic) Two Enzymic Mechanisms for Hydrogen Transport by (Dr H G Williams-Ashman, M Cassman and Margaret Klavins), 427
Œstrous Response by the Ovariectomized Ewe Seasonal Changes in the, to Progesterone and Œstrogen (Prof J I Raeside and M F McDonald), 458
'Off' Responses ('On' and), of the Olfactory Epithelium (Dr S F Takagi and Dr T Shibuya), 60
Offergeld, G, and van Cakenberghe, J Stoichiometry of Bismuth Telluride and related Compounds, 185
Office Management Association Clerical Salaries Analysis 1958, 698
Offspring of Alloxan-Diabetic Rabbits A Low Concentration of certain Blood Constituents observed in (Dr Otakar Sirek and Dr Anna Sirek), 456
Oftedal, Per Synthesis of Deoxyribonucleic Acid in Adult *Drosophila*, 1961
Ogilvie, Dr K W, and Winn, M M Evidence for Cosmic Ray Energy Spectrum Changes during a Forbush Decrease, 888
Ogilvie, Dr K W, and others Radiation Observations with Satellite 1958δ over Australia, 391
Ogston, Dr A G Resignation from the chairmanship of the Editorial Board of the *Biochemical Journal*, 508
O'Hagan, Dr J E Binding of Haem to Protein in Haemoglobin and Myoglobin, 1652
Decrease in Acid Strength of Propionate Side-Chains of Haematin on Reduction to Haem, 1808
Ohanessian, A Cytoplasmic Inheritance(Genic Control of the *Drosophila* Virus), 1012
OhEocha, Dr C, and Raftery, M Photoreactive Pigments in Flagellates—Phycoerythrins and Phycocyanins of Cryptomonads, 1049
Ohio State University 360-ft Radio Telescope (Prof John D Kraus), 669
Oil in Navigable Waters (P Barclay-Smith), 949
Oil (Mineral) Survival of Grasshopper Eggs kept for Long Periods in (Prof Eleanor H Slifer), 1424
Oil (Olive) Quantitative Estimation of the Fatty Acids of (J Gracian, E Vioque and Ma Pilar de la Maza), 1941
Oil (Paraffin-) Fixation Paper Electrophoretic Patterns obtained by (H Waldmann-Meyer), 1567
Oil Gaps Luminous Spots on Electrodes in Insulating (T W Dakin and Daniel Berg) 120
Oil Pollution of the Sea, Co-ordinating Advisory Committee on International Conference, 949
Oils (Crude Vegetable) Chromatographic Identification of the Antilipaemic X Factor of the Unsaponifiable Fraction of (Prof M C Nath, A Saikia and B I Uppin), 1635
Oils (Fish Liver) Isomers of Vitamin A in (Patricia S Brown, William P Blum and Max H Stern), 1377

Oilseed Phospholipids Sterol Glycosides in (Dr Francis Aylward and B W Nichols), 1319
Oka, Dr Sutemi, and others Nicotinamidase in *Mycobacteria*—a Method for Distinguishing Bovine Type Tubercle Bacilli from other *Mycobacteria*, 1743
Okano, A, and others Chemistry and Pharmacology of 16-Acetyl Digitalinum Verum, 1414
Oki, Yoshio Pathophysiological Effects of Circulating Ferritin, 1944
Okun, Dr Bernard Trends in Birth Rates in the United States since 1870, *review*, 134
Old, Dr Lloyd J, and others Effect of Bacillus Calmette-Guérin Infection on Transplanted Tumours in the Mouse, 291
Old Age Mental Health Problems in (World Health Organization of the United Nations, Technical Report Series No 71), 1844
Old Chemistry, *review* by Prof J R Partington, 1900
Old Testament The Value of π and the (Dr J Heading), 78
Olduvai A New Fossil Skull from (Dr L S B Leakey), 491
Olea europaea Oleuropeic Acid, a New Compound from (Baruch Shasha and Prof Jeshaia Leibowitz), 2019
Olefines produced by Apples Nature of the (Dr D F Meigh), 1072, (Dr F E Huelin and B H Kennett), 996, *errata*, 1535
Oleuropeic Acid, a New Compound from *Olea europaea* (Baruch Shasha and Prof Jeshaia Leibowitz), 2019
Olfactory Epithelium 'On' and 'Off' Responses of the (Dr S F Takagi and Dr T Shibuya), 60
Olfactory Perception Discrimination between Ebb and Flood Tide in Migrating Elvers (*Anguilla vulgaris* Turt) by means of (F Creutzberg), 1961
Olfactory Stimulation A Specific Response in the Hippocampus of the Rabbit to (B G Cragg), 1697
Olhagen, Dr Borje (Gullberg, Dr Ragnhild, and) Electrophoresis of Human Gastric Juice, 1848
Oligocene of Belgium Foraminifera of the (D A J Batjes), 321
Oligosaccharides (Liver Glucosyl), and Glycogen—Carbon-14 Dioxide Experiments with Hydrocortisone (Dr Hsien-Gieh Sie, Prof James Ashmore, Dr Robert Mahler and Prof William H Fishman), 1380
Olive Oil Quantitative Estimation of the Fatty Acids of (J Gracian, E Vioque and Mª Pilar de la Maza), 1941
Oliver, R, and Lajtha, Dr L G Biological Half-Life of Radioiron in Man, 1882
Olivetti, M, and others Abolition by Chlorpromazine of the Inhibiting Effect of Iproniazid on the Depletion of Adrenal Catechol Amines induced by Reserpine, B A 65
Olley, J, and others Radiation Observations with Satellite 1958δ over Australia, 391
O'Loughlin, Jean (McCrea, Prof J F, and) Effect of Concentrated Urea Solutions on the Infectivity and Haemagglutinin of Vaccinia Virus, 1497
Olympic Games (1964)—Prof Ryotaro Azuma B A 14
Ombrogenous Peats Occurrence of *Schoenus nigricans* L on (D J Bellamy), 1590
O'Moore, Dr L B Appointed chief of the Animal Production Division of An Foras Taluntais (The Agricultural Institute), Dublin, 29, work of, 29
'On' and 'Off'-Responses of the Olfactory Epithelium (Dr S F Takagi and Dr T Shibuya), 60
Onchospheres Infection of Cattle with *Cysticercus bovis* by the Injection of (G Froyd and M C Round), 1510
Oner, Dr N, and others Sugars of the Glycoside of the Root of *Marsdenia erecta* R Br, 1319
Ongul Islands in the Antarctic Natural Remanent Magnetization of Pre-Cambrian Gneiss of (T Nagata and Y Shimizu), 1472
Onion Roots Nuclear Deoxyribonucleic Acid Content and Endopolyploidy in the Meristem of (D Srinivasachar), B A 80
Onions Auxin and the Bulbing of (Dr J E Clark and Prof O V S Heath), 345
Onium Compounds in Brain Tissue Presence of certain, following Intravenous Administration to Rats (Prof Ruth R Levine), 1412
Ono, S, and Hagen, Prof P Pyridoxal Phosphate, a Coenzyme for Histidine Decarboxylase, 1143
Onsager, Prof Lars Co-operative Phenomena, 1195
Onset of Seed Dormancy Prevention of the, by Gibberellic Acid (Dr M Black and J M Naylor), 468, *erratum*, 857
Ontario Research Foundation Annual Report for 1958, 865
Ontario Veterinary College New Medical-Surgical Building of the, 695
Onwumechilli, Dr C A Possible Asymmetry in the Daily Range of the Geomagnetic Vertical Intensity around the Magnetic Equator, 51
Oocytes of some Fishes Development of the Yolk Nucleus in the (Prof A Stolk), 1746
Open Sea The—its Natural History (Sir Alister Hardy), Part 2, Fish and Fisheries, with Chapters on Whales, Turtles and Animals of the Sea Floor, *review* by S M Marshall, 666
Operations (Linear), and Classical Analysis, *review* by Prof L S Goddard, 1763
Operations Research Mathematical Methods of (Thomas L Saaty), *review* by Prof L S Goddard, 1763
  Mathematics and, *review* by Prof L S Goddard, 1763
Operators Linear (Nelson Dunford and Jacob T Schwartz), Part I, General Theory, *review* by Prof L S Goddard, 1762
Ophitron The (General Electric Co Ltd), 594
Ophiuroids Carrion-Eating by (A K Nagabhushanam and J S Colman), 285
Opossum (Brush-tailed), *Trichosurus vulpecula* in New Zealand Bionomics of the (R I Kean), 1388
Opsonins as Determinants of Survival in Intraperitoneal Infections of Mice (Dr C R Jenkin and Prof D Rowley), 474
Optical Activity of Stercobilin and *d*-Urobilin (Prof C H Gray, P M Jones, Dr W Klyne and Dr D C Nicholson), 41
Optical Properties of Semi-Conductors (Dr T S Moss), *review* by Dr R A Hyman, 1754
Optical Rotatory Power of Collagen (Dr R E Burge and R D Hynes), 1562
Optics, Classical and Modern, *review* by Dr J E Geake, 130
Optics (Classical) Concepts of (Dr John Strong), *review* by Dr J E Geake, 130
Optics (High-Resolution Fibre), using Sub-Micron Multiple Fibres (Dr N S Kapany), 881
Oral Tissue (Rat) Effect of Vitamin D on the Respiration of (L Zar and Prof J T Irving), 1410
Oravec, A A, and others Effect of the Potassium Salt of Gibberellic Acid on the Growth and Reproduction Rate of *Paramecium multimicronucleatum*, 1405
Orbit Observations (Satellite) Air Density in the Upper Atmosphere from (Dr G V Groves), 178
Orbits (Satellite) Density of the Upper Atmosphere from Analysis of—Further Results (D G King-Hele), 1267
Orchard Science, *review* by Prof H W Miles, 487
Orchids of Peru (C Scheinfurth), 409
Ordinary Differential Equations (Dr Wilfred Kaplan), *review* by Prof T A A Broadbent, 6
Oreopithecus A Contribution to the Odontology of (P M Butler and J R E Mills), 682
Orford, N W An Unusual Breeding Habitat of the Linnet, 650
Organ, R M Chemistry in the Preservation of Antiquities, 586
Organ Content and Adrenal Medullary Secretion of Catechol Amines Effects of 1,4-Dihydrazinophthalazine on (M Bygdeman and L Stjärne), 1646
Organ Culture Cell and (British Association for the Advancement of Science, Section I (Physiology and Biochemistry), Discussion on), 935
Organ Cultures of Total Mammary Glands of the Mouse (Dr F J A Prop), 379
Organic Acids Two-Dimensional High-Voltage Paper Electrophoresis of Amino- and other (Dr D Gross), 1298
Organic Acids in Rose Hips (Dr G A D Jackson and S E Y Barakat), 1953
Organic Chemistry Progress in (edited by Dr J W Cook), Vol 4, *review* by Dr K H Overton, 1439
Organic Compounds Nitration of Hydrocarbons and other (A V Topchiev), translated from the Russian by Catherine Matthews, *review* by Prof M J S Dewar, 577
  Oxidation of (Symposium on, at Queen Mary College, London), 326
  Some Remarks on the Thermodynamic Properties of (Prof George S Parks), 1194
Organic Compounds in the Blood Post-Exposure Analysis of, by a Rapid Infra-red Technique (Dr R D Stewart, D S Erley, T R Torkelson and C L Hake), 192
Organic Compounds labelled with Isotopes of the Halogens, Hydrogen, Nitrogen, Oxygen, Phosphorus and Sulfur (Arthur Murray, III, and D Lloyd Williams), (Organic Syntheses with Isotopes, Part 2), *review* by Dr G Eglinton, 1830
Organic Compounds (Cyanocarbon) Histochemical Use of the (Prof John F Lhotka), 1153
Organic Diluents Effect of Emulsifiers and, in Soil Insecticide and Nematicide Formulations (F T Phillips), 1512
Organic Matter of a Podzol Soil Oxygen-containing Functional Groups in the (J R Wright and M Schnitzer), 1462
Organic Matter (Soil) Titration Curves of (R S Beckwith), 745
Organic Molecules Steric Effects in, *review* by Dr G Eglinton, 1522
  An X-Ray Study of Rigid-Body and Internal Vibrations of (Dame Kathleen Lonsdale and Dr H Judith Milledge), 1545
Organic-Phosphorus Compounds (Bradford Institute of Technology Symposium on), 1688
Organic Reactions Tracer Applications for the Study of (John G Burr, Jr), *review* by Dr A I Scott, 1902
Organic Syntheses Use of Isotopes in, *review* by Dr G Eglinton, 1830
Organic Syntheses with Isotopes (Arthur Murray, III, and D Lloyd Williams), Part 2, Organic Compounds labelled with Isotopes of the Halogens, Hydrogen, Nitrogen, Oxygen, Phosphorus and Sulfur, *review* by Dr G Eglinton, 1830
Organic Synthesis, Vol 37, 1957 (edited by James Cason), Vol 38, 1958 (edited by John C Sheehan), *review* by Prof John Read, 134
Organism (Animal) Thiosulphate Metabolism in the (Prof Boleslaw Skarzynski, Tadeusz W Szczepkowski and Miroslawa Weber), 994
Organisms (*Brucella*) Bacteriophage Typing applied to Strains of (Prof G C van Drimmelen) 1079
Organisms (Fossil Calcareous) Determination of the Temperatures of Ancient Seas by the Measurement of the Oxygen Isotopes Ratio in (Y A Birstein), 1025
Organization Industrial Technical (Institute of the Rubber Industry Conference on), 322
Organization for European Economic Co-operation First Meeting of the International Board of Management of the *Dragon* Project, 24
  Dragon Project of the, 24, 942
Organization for European Economic Co-operation (European Nuclear Energy Agency) Second Fuel Charge for the Boiling Heavy Water Reactor Project at Halden, Norway, 1844
Organization for European Economic Co-operation (European Productivity Agency) Project 335, Fitting the Job to the Worker, a Survey of American and European Working Conditions in Industry, 422
Organization of Scientific and Technological Research in Britain, 1255
Organization (Functional), of the Respiratory Chain in Liver Mitochondria (Dr Tokuji Kimura and Dr Thomas P Singer), 791
Organophosphorus Poisoning in the House-Fly Esterase Inhibition and (Dr D Stegwee), 1253
Organs Artificial—Biological Applications (Prof A Hemingway), B A 45
Organs (Fungal Arbuscular) Production of, on Laboratory Media (G A Atkins), 1738
Orientation of Animals to Polarized Light (Dr H Kalmus), 228
'Origami', the Ancient Japanese Art of Paper-folding, 770
Origin of the Deep Sea Fauna Palaeo-temperatures and the, 1025
Origin of Species Genetics and the (British Association for the Advancement of Science, Sections D (Zoology) and K (Botany), Symposium on), 587
  The Young Darwin and the (Prof C F A Pantin), 1533
Origin of the Worzel Deep-Sea Ash (Edward Anders and Dr D Nelson Limber), 44
Origin and Dispersal of Flowering Plants (Prof A S Boughey), 1200
Origin (Biological), and Configuration of 10-Hydroxy-Δ^2-decenoic Acid (Dr S A Barker, Dr A B Foster, D C Lamb and Dr L M Jackman), 634
Origin (Telluric), of the Whistler Medium (Dr Francis S Johnson), 1787
Origins of Love, 1203

Origins (Etruscan) Ciba Foundation Symposium on Medical Biology and (edited by G E W Wolstenholme and Cecilia M O'Connor), *review* by Madeleine Smith, 1348
Origins and Methods of the Sciences, *review* by Prof A V Hill, 4
O'Rourke, Prof Fergus J (Barry, J M, and) Species Specificity of Fish Mucus, 2039
Osmond, D G Appointed lecturer in anatomy at the University of Bristol, 322
Oster, Prof Gerald, and Broyde, Dr Barret A Sensitive Chemical Dosimeter for Ionizing Radiation, 545
Ostling, S G (Marsden, N V B, and) Accumulation of Dextran in Human Red Cells after Haemolysis, 723
Ostrinia nubilalis (Hbn) (Lepidoptera Pyralidae) Chemical Changes associated with Diapause in the European Corn Borer (J A Mutchmor and J H Maruzek), 1077
Oth, Andre (Castermans, Andre, and) Transplantation Immunity—Separation of Antigenic Components from Isolated Nuclei, 1224
Otsuji, Dr Nozomu, and others Induction of Phage Formation in the Lysogenic *Escherichia coli* K-12 by Mitomycin C, 1079
Outbreaks Forecasting Locust (Dr D L Gunn and P M Symmons), 1425
Outbreaks of Plant Diseases caused by Arabis Mosaic Virus Rôle of a Dagger Nematode (*Xiphinema* sp) in (Dr B D Harrison and Dr C H Cadman), 1624
Outbursts (Radio) Association of, with Solar Flares (L D de Feiter, A D Fokker and J Roosen), 805
Outer Atmosphere Directional Observations of Radio Noise from the (G R A Ellis and D G Cartwright), 1307
  Spaced Observations of Radio Noise from the (G R A Ellis, D G Cartwright and J R V Groves), 1391
Output (Carbon Dioxide), of Individual Insects The Infra-Red Gas Analyser as a Means of Measuring the (Dr A G Hamilton), 367
Output (Cardiac), in Horses (E W Fisher and R G Dalton), 2020
Ova (Rabbit) Fertilization of, *in vitro* (Dr M C Chang), 466
Ovarian Transplantation (Interstrain), in Lethally Irradiated Mice after Bone Marrow Therapy (Prof W St Amand and L H Smith), 1503
Ovariectomized Ewe Seasonal Changes in the Œstrous Response by the, to Progesterone and Œstrogen (Prof J I Raeside and M F McDonald), 458
Ovariectomized Ewes Maintenance of Pregnancy in, by means of Progesterone (N W Moore and L E A Rowson), 1410
Ovaries of Mice translated to the Liver, Kidney and Adjacent Tissues Tumourigenesis in (Dr Mary J Guthrie), 916
Ovaries (Inflorescences, Flowers and), of an Apomict, *Aerva tomentosa* Forsk *In vitro* Culture of the (Prem Murgai), 72
Ovariole Number in the Progeny of the Migratory Locust Maternal Control of (F O Albrecht, M Verdier and R E Blackith), 103
Ovary of the Rat Site of Production of Œstrogen in the (Dr Bengt Falck), 1082
Ovenall, Dr Derick W Electron Paramagnetic Resonance at 4 2°K of γ-Irradiated Polymethyl Methacrylate and Polymethacrylic Acid, 181
Overgaard-Hansen, Dr Kay, and Lassen, Dr Ulrik V Active Transport of Uric Acid through the Human Erythrocyte Membrane, 553
Overseas Distribution of British Books and Films, 1448
Overseas Information Services British, 1692
Overseas Research Council Establishment of the, B A 14
Overton, Dr K H Progress in Organic Chemistry, *review*, 1439
Ovine Abortion due to Toxoplasmosis (Dr J K A Beverley and W A Watson), 2041
Owen, W S, and others Atomic Mechanisms of Fracture (Tensile Fracture of Mild Steels), 325
Oxalate (Lead) Thermal Decomposition of Irradiated (P J Herley and E G Prout), 445
Oxidase (Indoleacetic Acid) A Possible Rôle of, in Crown Gall Tumour Induction (Dr Jacques Lipetz), 1076
Oxidase (Monoamine), in the Developing Rat Brain Histochemical Study of (Nobuo Shimizu and Nogaaki Morikawa), 650
Oxidase (Pyridine Nucleotide), from Heart Sarcosomes Corticosterone Inhibition of (P K Jensen), 451
Oxidase (Tryptophan Peroxidase-), in *Drosophila melanogaster* Genetic Control of (Corrado Baglioni), 1084
Oxidase (Tryptophan Peroxidase-) Enzyme System Specificity of the (Dr R H Marchant), 1711
Oxidase Activity in the Mitochondria of the Human Heart Histochemical Localization of (Dr M S Burstone), 476
Oxidase Activity (Cytochrome), in the Sea Urchin Egg An Inhibitor of (Rachele Maggio and Alberto Monroy), 68
Oxidase Activity (Xanthine) A Rapid and Sensitive Method for the Determination of, using the Oxygen Electrode (Metry Bacila and Dr Gilberto G Villela), 1394
Oxidase Apo-Protein (D-Amino-Acid) Binding of the Sulphydryl Group in, with Flavin Adenine Dinucleotide (Dr Kunio Yagi and Takayuki Ozawa), 1227
Oxidase Apo-Protein (D-Amino-Acid), and Benzoate Change of Absorption Spectrum of Flavin Adenine Dinucleotide by its Binding with both (Dr Kunio Yagi, Takayuki Ozawa and Minoru Harada), 1938
Oxidase Systems (*d*-Amino-Acid) Effect of Chlorpromazine upon Isolated (Dr Andrew Lasslo and Anne L Meyer), 1922
Oxidation of Ascorbic Acid Presence in Rose Hips of Substances Inhibiting the (Dr G A D Jackson and R B Wood), 902
Oxidation of Ethyl Alcohol by a Mixture of Hydrogen Peroxide and Ferric Salts (Dr Mordechai L Kremer), 720
Oxidation of Krebs Cycle Acids by Apple Tissue (M D Hatch, J A Pearson, A Millerd and R N Robertson), 506
Oxidation of Organic Compounds (Symposium on, at Queen Mary College, London), 326
α-Oxidation of Indoleacetonitrile (H F Taylor and Prof R L Wain), 1142
Oxidation (Aerobic), of D-Xylose Glycolaldehyde Trapped from, by *Torulopsis utilis* (V Bolcato and G Leggiero), 1318
Oxidation (Diphosphopyridine Nucleotide) Inhibition of Reduced, by Ammonia (R T Wedding and H M Vines), 1226
Oxidation (Fat) and Haematin Systems in Cheese (Tallowy Discoloration in Cheddar Cheese), (C G Rammell), 1296
Oxidation (Fat), and Trace Metals in Cheese (Tallowy Discoloration in Cheddar Cheese), (F Bishop), 1295
Oxidation (Pyrogallol), in the System Iron(III)–Cellulose Reaction-directing Properties of Non-enzymic Macromolecules— (N S Goodmand and S M Siegel), 53
Oxidation (Selective), of Tetrapyrrole Side-Chains (J Barrett and P Clezy), 1988
Oxidation and Reduction Principles of (Dr A G Sharpe), *review* by Dr V Gold, 1902
Oxidations stimulated by Dinitrophenol Need for Inorganic Phosphate in (P Borst and Prof E C Slater), 1396
Oxidative Dissimilation of *p*-Aminobenzoic Acid by *p*-Aminosalicylic Acid Antagonism of the (Prof Norman N Durham and Jerry S Hubbard), 1398
Oxidative Phosphorylation Protein Synthesis and, in Isolated Rat Liver Mitochondria (P J Reis, J L Coote and T S Work), 165
Oxidative Phosphorylation in *Azotobacter vinelandii* Fractionation of the System bringing about (H G Hovenkamp), 471
Oxidative Phosphorylation in Guinea Pig Heart Sarcosomes Reversal by Acetylcholine of the Inhibition by Thyroxine of (Heitor Medina and Metry Bacila), 1066
Oxidative Phosphorylation (Mitochondrial), in Intact Ascites Tumour Cells Efficiency of the (Dr P Emmelot and C J Bos), 2024
Oxidative and Phosphorylative Activities of Cytoplasmic Particles from Plant Tissue Cultures (Taiki Tamaoki, Prof A C Hildebrandt, A J Riker, R H Burris and Bunji Hagihara), 1491
Oxide (Cobaltic) Pellets Effect of, on the Vitamin B_{12} Content of Ewes' Milk (L I Hart and E D Andrews), 1242
Oxide (Deuterium) Culture of Algae and other Micro-organisms in (Henry L Crespi, Sylvia M Archer and Joseph J Katz), 729
  Effects of, on the Synthesis of T5 and T7 Bacteriophages (E L Rothstein, L A Manson, R Hartzell, jun, and David Kritchevsky), 1167
  Saliva-Serum Ratios of, after Administration of Heavy Water (Nan Taggart and Dr F E Hytten), 457
Oxide (Phenazine Di-*N*-), as a Carcinostatic Agent (Arthur Furst, Claire Klausner and Windsor C Cutting), 908
Oxide (Zinc) Effect of Gamma-Radiation on the Synthesis of Methanol over (T I Barry and R Roberts), 1061
Oxide Cathode Current Fluctuations in the (Margaret Chisholm and Dr L Jacob), 1058
Oxides (Amine) Prophylactic Effects of, in Radiation Injury in Mice (Dr Thomas J Haley, Dr Anna M Flesher and Dr Nathan Komesu), 198
Oxine and its Sulphonic Acid Stability of Metal Complexes of (Prof Adrien Albert and Prof Reino Nasanen), 449
Oxygen Effect of, on Endogenous Metabolism of a Respiratory-deficient Brewer's Yeast (V E Chester), 1956
Oxygen in Irradiated Solutions Aromatic Ring Opening in the Presence of (Israel Leoff and Gabriel Stein), 901
Oxygen-containing Functional Groups in the Organic Matter of a Podzol Soil (J R Wright and M Schnitzer), 1462
Oxygen (High-Pressure), and Radiotherapy, 94
Oxygen (Molecular) Incorporation of, in Bacterial Cells utilizing Hydrocarbons for Growth (E R Leadbetter and J W Foster), 1428
Oxygen Consumption (Increased), in Rats during Irradiation (Dr A Vacek), 197
Oxygen Electrode A Rapid and Sensitive Method for the Determination of Xanthine Oxidase Activity using the (Metry Bacila and Dr Gilberto G Villela), 1394
Oxygen Isotope Variations in Antarctic Snow Samples (Dr R Gonfiantini and Prof E Picciotto), 1557
Oxygen Isotopes Ratio in Fossil Calcareous Organisms Determination of the Temperatures of Ancient Seas by the Measurement of the (Y A Birstein), 1025
Oxygen Tension Effect of, on Haem and Porphyrin Biosynthesis (J E Falk, R J Porra, Ann Brown, F Moss and Helen E Larminie), 1217
Oxygen Uptake of Glycerol-extracted Muscle Fibres (James A Wilson, Paul R Elliott, Prof Karl F Guthe and David G Shappirio), 1947
Oxytocic and Pressor Activity Peptides with, obtained from Acidified Rat Serum (Prof H Croxatto, T Pereda and R Mellada), 1496
Oxytocin A New Crystalline Salt of (Dr Miklos Bodanszky and Prof Vincent du Vigneaud), 981, *erratum*, 1777
  Specific and Sensitive Assay Method for Vasopressin and, using Glass-Paper Chromatography (Akira Arimura and Prof Joseph F Dingman), 1874
Oxytocin and Vasopressin Gel Filtration as a Method for Purification of Protein-bound Peptides as exemplified by (E B Lindner, Dr A Elmqvist and Dr J Porath), 1565
Oxytocin (Arginine Vasotocin and), in Neurohypophysial Extracts from Cold-blooded Vertebrates Pharmacological Evidence for the Presence of (Active Principles for the Neurohypophysis of Cold-blooded Vertebrates), (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464
O-Phosphorylated Analogue Action of Trypsin on α-Carbethoxy-L-lysyl-L-serylglycine and its (Dr D Theodoropoulos, H Bennich, G Folsch and Prof O Mellander), 187
O-Phosphorylated and Unphosphorylated Peptide-Substrates suitable for Tryptic Action (Dr D Theodoropoulos, H Bennich and Prof O Mellander), 270
Oyolu, C *Capsicum* Species of West Africa, 1163
Ozawa, Takayuki, and others Complex Formation of Chlorpromazine with Flavins, 982
  Change of Absorption Spectrum of Flavin Adenine Dinucleotide by its Binding with both D-Amino Acid Oxidase Apo-Protein and Benzoate, 1938
  Occurrence of Polynucleotide Phosphorylase in Atypical Epithelioma of Rat 1939
Ozawa, Takayuki (Yagi, Dr Kunio, and) Binding of the Sulphydryl Group in D-Amino-Acid Oxidase Apo-Protein with Flavin Adenine Dinucleotide, 1227
Ozeki, H, and others Production of Colicine by Single Bacteria, 337

PACAULT, A Thermodynamics (Experimental Thermochemistry), 1607
Pace, Dr J (McDermott, E E, and) Extraction of the Total Protein from Wheaten Flour in the Form of Soluble Derivatives, 546

Pachytene in *Puccinia kraussiana* Cooke, on *Smilax kraussiana* (Dr Eva Sansome), 1820
Pacific Ocean Evidence of a South Equatorial Countercurrent in the (Joseph L Reid, jun), 209
Pacific Ocean (western), and eastern Indian Ocean Oceanographic and Geophysical Investigation of the (Scripps Institution of Oceanography), 24
Pacific Sardine *Sardinops caerulea* (Girard) Behavior and Reactions of the, under the Influence of White and Colored Lights and Darkness (Dr A S Loukashkin and Dr N Grant), 865
Packaging New Techniques in, *review* by Dr V G W Harrison, 1437
  Pressurized–Aerosols (A Herzka and J Pickthall), *review* by Dr V G W Harrison, 1437
Packed and Capillary Gas Chromatographic Columns Comparison of Efficiency and Separating Power of (Dr J H Purnell), 2009
Packer, Dr D M , and others Lyman-Alpha Photographs of the Sun, 8
Padmavathi, P B (Seshachar, Prof B R , and) Conjugation in *Spirostomum*, 1510
Paecht, Dr Mella, and Katchalsky, Prof A Spontaneous De-amination of Amino-acid Phosphates under Physiological Conditions, 1489
Page, F J Taylor At the Conference of the Mammal Society of the British Isles (Activity of Mature Bucks in Fraying Young Trees), 30
Page, F M Reduction of the $FeS_2O_3^+$ Ion at the Dropping Mercury Electrode, 1481
Page, R W Appointed lecturer in mechanical engineering at the University of Southampton, 595
Page, S G Awarded an Overseas Scholarship by the Royal Commission for the Exhibition of 1851, 409
Paget-Tomlinson, E W Models of Marine Engines at the Liverpool Public Museums, 1534
Pain, H J Thermonuclear Energy (Shock Waves in Gases), 1017
Pain (Dental) Association between Colour of the Iris of the Eye and Reaction to (Dr Philip R N Sutton), 122
Paint, Colour and Varnish Manufacturers (British), Research Association of Retirement of Dr L A Jordan as founder-director, 852
Pakistan Planning in (Political and Economic Planning, Broadsheet No 433), 504
Pal, R , and Krishnamurthy, B S Induced Mutations of X-Ray Irradiations in *Culex fatigans* Wied (1828), 658
Palade, Dr G E Comparative Studies in Ultrastructure (Microsomes and Ribonucleoprotein Particles), 1445
Palaeomagnetic Studies of Cenozoic Volcanic Rocks in New Zealand (Dr D S Coombs and Dr T Hatherton), 883
Palaeomagnetism of some Dolerite Intrusions from the Theron Mountains and Whichaway Nunataks, Antartica (D J Blundell and P J Stephenson), 1860
Palaeomagnetism in some Norwegian Sparagmites and the Late Pre-Cambrian Ice Age (W B Harland and D E T Bidgood), 1860
Palaeomagnetism and Rotation of Newfoundland (Dr P M Du Bois), B A 63
Palaeontological Journal (published in the Russian language by the Academy of Sciences of the U S S R), 410
Palaeontology Recent Developments and Trends in (Prof O M B Bulman), B A 42
Palaeotemperatures and the Origin of the Deep Sea Fauna, 1025
Palay, Dr S A Comparative Studies in Ultrastructure (The Fine Structure of Vertebrate Neurons and their Processes), 1446
Palearctic Fauna The Birds of the—Order Passeriformes (Dr Charles Vaurie), *review* by Sir Landsborough Thomson, 666
Palm The Coconut (Dr K P V Menon and Dr K M Pandalai), *review* by Prof C W Wardlaw, 1760
Palmeira, R (Sarabhai, Dr V , and) North–South Anisotropy and Anticipatory Increase of Intensity associated with the Cosmic-Ray Storm of February 11, 1958, 1204
Palmen, Prof Erik Herbert Elected a member of the Geophysics and Meteorology Section of the Leopoldina Academy of Natural Sciences, 595
Palmer, Dr H P International Conference of Radio Astronomers, *review*, 1755
Palmer, P F (Jackson, Dr J S , and) Special Ceramics (Apparatus designed for Hot-pressing small specimens of Refractory Hard Materials to High Density), 1116
Palmer, R W , and others Ionization Phenomena in Gases (Recent Measurements on the Growth of Pre-breakdown Ionization Currents for Air), 1354
Palmitic Acid Biosynthesis of Corynomycolic Acid from Two Molecules of (Dr Mireille Gastambide-Odier and Prof E Lederer), 1563
Pampfer, E (Meyer, J , and) Nitrogen Content of Rain Water collected in the Humid Central Congo Basin, 717
Panagglutinin Production of an Agglutinating Auto-Antibody, Active upon Tanned Erythrocytes in the Rabbit (P O Hubinont, P Ghysdael and O Thys), 1250
Panbiogeography, or an Introductory Synthesis of Zoogeography, Phytogeography and Geology (Dr Léon Croizat), Vol 1, The New World , Vol 2a, The Old World , Vol 2b, The Old World (continuation), *review* by Prof Ronald Good, 924
Pancreas Slices Effect of Acetylcholine on the Incorporation of Radiophosphorus into the Phosphatido-Peptide Fraction of (Prof C G Huggins), 1412
Pandalai, Dr K M , and Pillai, R V Albinism in Coconut Seedlings, 1163
Pandalai, Dr K M (Menon, Dr K P V , and) The Coconut Palm, *review* by Prof C W Wardlaw, 1760
Pandya, J R (Pandya, Dr N S , and) Etching of Calcite, 894
Pandya, Dr N S , and Pandya, J R Etching of Calcite, 894
Panicum antidotale Floral Malformation in, caused by a Species of *Eriophyes* (Dr V M Desai and Dr M J Thirumalachar), 1586
Panonychus citri (McG) A Suspected Virus Disease of the Citrus Red Mite (Dr Kenneth M Smith, G J Hills, F Munger and J E Gilmore), 70
Panov, Prof Dimitri Silver Medal of the City of Paris awarded to I I Basilewsky for, B A 16
Pantin, Prof C F A Elected president for 1959-60 of the Linnean Society of London, B A 16
  Biology and Physics, 1194
  The Young Darwin and the 'Origin of Species', 1533
Panton, C J Appointed to a Phillips Petroleum Co research studentship at University College of North Staffordshire, 322
Pantothenic Acid Deficiency and Ubiquinone Levels in Rat Liver Mitochondria (A S Aiyar, G A Sulebele, D V Rege and A Sreenivasan), 1867
Papain-injected Rabbits Cartilage Homografts in (M B L Craigmyle), 1243
Papavassiliou, Dr J Production of Colicines in Simmons's Citrate Agar, 1339
Paper A Two-Dimensional System for the Separation of Amino-Acids and Peptides on (Virginia Richmond and Brian S Hartley), 1869
  Use of Porter–Silber and Schiff Reagents as Spot Tests for Steroids applied on, and their Application to the Study of Rat Adrenal Lipids (Dr Marion K Birmingham), B A 67
Paper Chromatograms Autoradiography of Tritium-labelled Compounds on (Dr A W Rogers), 721
  Detection of 2 4-Dinitrophenyl Amino-Acids on (Dr A H Maddy), 1397
Paper-Chromatographic Method for the Determination of Suitable Buffer Systems for Countercurrent Distribution (Andrzej Waksmundzki and Edward Soczewinski), 977
Paper Chromatographic Method (New Two-Dimensional), applied to the Separation of Amino-acids (C S Knight), 1486
Paper Chromatographic Separation of Components of Rose Bengal Labelled with Iodine-131 (Fausto W Lima and Rômulo R Pieroni), 1065
Paper Chromatography Applications of, to Systematics—Recombination of Parental Biochemical Components in a *Baptisia* Hybrid Population (Dr R E Alston and Dr B L Turner), 285
Paper Chromatography of Cell Fragments (A T Wilson), 2016
Paper Chromatography of Corticosteroids at Room Temperature (J Tuzson), 1937
Paper Chromatography (Quantitative), based on the Sub-Micro Titration of Derivatives containing Nitro Groups (L Blom and J Caris), 1313
Paper Chromatography and Paper Electrophoresis A Manual of (Richard J Block, Emmett L Durrum and Gunter Zweig), second edition, *review* by Dr R Consden, 1436
Paper Electrophoresis A Manual of Paper Chromatography and (Richard J Block, Emmett L Durrum and Gunter Zweig), second edition, *review* by Dr R Consden, 1436
Paper Electrophoresis of Hippopotamus Haemoglobin (D H L Rollinson and G D Lomax), 1653
Paper Electrophoresis of Trypanosomal Extracts (Dr Robert S Desowitz), 986
Paper Electrophoresis (High-Voltage), of Aliphatic Amines and related Compounds (Dr D Gross), 1633
Paper Electrophoresis (Two-Dimensional High-Voltage), of Amino- and other Organic Acids (Dr D Gross), 1298
Paper Electrophoretic Patterns obtained by Paraffin-Oil Fixation (H Waldmann-Meyer), 1567
Paper-folding Exhibit at Cooper Union's Museum for the Arts of Decoration, 770
Papermaking Fibres Fundamentals of—Transactions of the Symposium held at Cambridge, 1957 (edited by Francis Bolam), *review* by Dr Julius Grant, 1011
Papierchromatographie (Dr Friedrich Cramer), vierte Auflage, *review* by Dr R Consden, 1436
Papierchromatographie Handbuch der (herausgegeben von Dr I M Hais und Dr K Macek), Band I, Grundlagen und Technik, *review* by Dr R Consden, 1436
Para-Isomers (*Meta*- and), of the Xylenes, Cresols and Toluidines by Gas Solid Chromatography Separation of the (M A Hughes, D White and Prof A L Roberts), 1796
Parabiosis Tolerance to Skin Homografts of Adult Mice after (Dr B A Rubin), 205
Parabiotic Mice Skin Homografts in (Anna Skowron-Cendrzak and Barbara Konieczna-Marczynska), 1590
Paraffin-Detergent Interactions in Aqueous Systems Solid State Rheological Study of the Mechanism of (F J Radd and L H Crowder), 443
Paraffin-Oil Fixation Paper Electrophoretic Patterns obtained by (H Waldmann-Meyer), 1567
Paraffin-Wax Fraction from Tobacco Leaf and Tobacco Smoke Composition of a (Dr W Carruthers and Dr R A W Johnstone), 1131
Paralysing Activity of *d*-Tubocurarine Chloride Increase by Chlorothiazide of the (Prof W Ferrari, G L Gessa and G Sangiorgi), 1235
Paralysis (Immunological), and Unresponsiveness Specific Inhibition of Antibody Formation during (Dr E Sercarz and Dr A H Coons), 1080
Paramagnetic Resonance (Electron), at 4 2° K of λ-Irradiated Polymethyl Methacrylate and Polymethacrylic Acid (Dr Derick W Ovenall), 181
Paramecium multimicro-nucleatum Effect of the Potassium Salt of Gibberellic Acid on the Growth and Reproduction Rate of (A A Oravec, N G Strovilas, J L Beal and Arthur Tye), 1405
Parasitic Animals (Dr Geoffrey Lapage), second edition, *review* by Dr C A Wright, 1011
Parasitic Fungi British (W C Moore), *review* by Dr Lilian E Hawker, 1977
Parasitism in Gram-Positive Bacteria Characters associated with (Dr K A Bisset), B A 29
Parasitism (Avian Brood) Prolactin in the Cowbird's Pituitary in relation to (Prof E O Hohn), 2030
Parathyroid Tissue Fragments Maintenance of, on Agar Substrates (Dr John H Wallace, Dr George J Hill, Jean M McCarthy and Dr John R Brooks), 1734
Parbrook, Dr H D Appointed to a senior lectureship in physics–acoustics in the University of Liverpool, 410
Parc National de la Garamba, Exploration du Mission H de Saeger, Fasc 9, Écologie et Biologie des Grands Mammifères (Primates, Carnivores, Ongulés), (Jacques Verschuren), 155
Pardee, A B Cytoplasmic Inheritance (Genotypic Change and the Rate of Enzyme Induction), 1012
Parenchyma (Lacunal), of *Mimosa pudica* Changes in the, in Diurnal and Nocturnal Conditions (Hideo Toriyama), 737
Parenchymatous Liver Cells Some Enzymatic Properties of Suspensions of (Dr Keith S Henley, Ole Sorensen and H Marvin Pollard), 1400
Parenchymatous Spleno-Pulmonary Venous Anastomosis Establishment of (Dr George R Walker, Dr Paul Field and Dr Patrick E Conen), 703

Parental Biochemical Components in a *Baptisia* Hybrid Population Applications of Paper Chromatography to Systematics—Recombination of (Dr R E Alston and Dr B L Turner), 285
Parenti, Dr M A, and others Sulphonamides with Diuretic Activity, 1711
Pargeter, A R At the Annual General Meeting and Conference of the Mathematical Association (Plaited Polyhedra), 33
Paris Symposium on Radio Astronomy, 1958 (edited by Ronald N Bracewell), *review* by Dr H P Palmer, 1755
Paris (City of) Medal Awards, B A 16
Park, D The Cellular Slime Molds, *review*, 1976
Park, R Appointed lecturer in civil engineering at the University of Bristol, 322
Park (Banff National), Alberta Mammals of (A W Banfield), 594
Parker, Dr C A Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Present Methods for Analysing High-purity Materials), 692
Parker, Dr C A, and Rees, W T Photolysis of Thionine in Rigid Medium—Measurement of Spectrofluorimetry, 1223
Parker, E R Atomic Mechanisms of Fracture (Cleavage Fracture in Tension of Single Crystals of Magnesium Oxide), 325
Parker, K D, and Rudall, K M Biological Fibres, B A 26
Parker, Prof Robert L International Mineralogical Association—First General Meeting, 1909
  Alpine Mineral Fissures, 1909
Parker, W Appointed to a research fellowship in chemistry in the University of Glasgow, 1915
Parker, W G, and Ruston, G Chemistry of Propellants (Merits of Utilizing High-Energy Propellants), 778
Parkes, Dr A S Dietary Factors in the Homograft Reaction, 699
  Biological Problems arising from the Control of Pests and Diseases, 1102
Parkes, Dr E W Appointed to the new chair of engineering in the University of Leicester, 938, work of, 938
Parkhouse, R M E, and others A Haemoglobin with Unusual Alkaline-denaturation Properties in a Turkish-Cypriot Woman, 1876
Parkin, Michael Retirement from the Department of Glass Technology in the University of Sheffield, 1271, work of, 1271
Parkinson, Joan Effect of Pempidine on the *in vitro* Synthesis of Acetylcholine, 554
Parks, Prof George S Some Remarks on the Thermodynamic Properties of Organic Compounds (Hugh M Huffman Memorial Lecture of Yale University), 1194
Parks, P C Appointed lecturer in aeronautical engineering at the University of Southampton, 1915
Parks (National), and Nuclear Power Stations in Britain, 1005
Parliamentary Responsibility for Science and Technology, 1190
Paronetto, Dr Fiorenzo Interfering Substances in the Determination of Glucosamine Synthesis, 1317
Parotid Tumour Virus (Polyoma Virus) Antibody Status of Mice and Response of their Litters to (Lloyd W Law, Clyde J Dawe, Wallace P Rowe and Janet W Hartley), 1420
Parr, G (Godfrey, J W, and) The Technical Writer, *review* by A L Bacharach, 1749
Parr, H C M *Stomoxys* Control in Uganda, East Africa, 829
Parr, N L, and Martin, G F Special Ceramics (Measurement of Creep at High Temperature), 1116
Parr, N L, and others Special Ceramics (Silicon Nitride—its Preparation, its Properties as an Engineering Material and its Microstructure), 1116
Parr and Smolt Stages of the Atlantic Salmon Sodium Regulation in the Blood of (Prof H J Koch, J C Evans and E Bergstrom), 283
Parrini, L (Tessari, L, and) Glutamic-Pyruvic Transaminase in Rabbit's Long Bones, 904
Parry, J V L (Essen, Dr L, and) An Improved Caesium Frequency and Time Standard, 1791
Parsloe, Guy *Obituary* of Sir William Larke, 21
'Parsnip' Dermatitis (B J Youngman), 594
Parsons, Dr T R, and Strickland, Dr J D H Proximate Analysis of Marine Standing Crops, 2038
Parthasarathy, S, and Bindal, V N Ultrasonic Absorption in Acetic Acid at 450 kc/s by the Calorimetric Method, 631
Parthenocarpy in *Rosa arvensis* Huds Induction of, with Gibberellic Acid (M V Prosser and G A D Jackson), 108
Partial Chemical Characterization of Maize Coleoptile Cell Walls prepared with the Aid of a Continually Renewable Filter (Prof Aleksander Kivilaan, Teofila C Beaman and Robert S Bandurski), B A 81
Partial Differential Equations Numerical Analysis and (George E Forsythe and Paul C Rosenbloom), *review* by Prof T A A Broadbent, 576
Partial Identification of Lysins and Agglutinins in Lymphomatous Mouse Tissue (Dr Eric Ponder and Ruth V Ponder), 819
Partially Distinguishable Coins Heads-Tails Statistics for Two (Gabriel Weinreich), 1825
Particle (Virus) Rotational Friction Coefficients of Models of Tobacco Mosaic Virus and the Size of the (Dr A J Haltner and Dr B H Zimm), 265
Particle Physics (Elementary) Development of Bubble Chambers and some recent Bubble Chamber Results in (Dr D A Glaser), 954
Particle Tracks (Low-Energy) Bubble Counting on (I R Birss), 1474
Particles (Autoradiographed Radioactive) Electron Microscopy of (L A George, II, and G S Vogt), 1474
Particles (Bentonite) Detection of Thyroid Antibodies using (Dr J A M Ager, Dr M S R Hutt and G Smitn), 478
Particles (Cytoplasmic), from Plant Tissue Cultures Oxidative and Phosphorylative Activities of (Taiki Tamaoki, Prof A C Hildebrandt, A J Riker, R H Burris and Bunji Hagihara), 1491
Particles (Elementary) The Physics of (Prof J D Jackson), *review* by P T Matthews, 1677
Particles (Insulating), on Cathode Surfaces—their Effect upon Electrical Discharges (L B Griffiths and P C L Pfeil), 1475
Particles (Titanium Dioxide Pigment) Forces between (James E Latty and Dr W C Clark), 49
Particles (Turnip Yellow Mosaic Virus Nucleoprotein), with Differing Biological and Physical Properties (R E F Matthews), 530
Particles (Zinc Phosphide) Absorption of (Dr A S Curry, Dr D E Price and Dr F G Tryhorn), 642
Particules Détecteurs de (Compteurs et Scintillateurs), Mécanisme et Réalisation (Daniel Blanc), *review* by Dr E B Paul, 1977
Partington, Prof J R *Obituary* of Dr E J Holmyard, 1360
  The National Chemical Laboratory, 1779
  Old Chemistry, *review*, 1900
Partition (Ionic), and Fine Structure in Muscle (Dr Shirley E Simon, 1978
Partition Chromatography Volatile Liquid (Dr Roger S Porter and Dr Julian F Johnson), 978
Partnership for Progress—International Technical Co-operation (Annals of the American Academy of Political and Social Science, May 1959), *review* by R Brightman, 1673
Pascal, Blaise—the Life and Work of a Realist (Ernest Mortimer), *review* by F I G Rawlins, 388
Passage of Insulin through the Wall of the Gastro-intestinal Tract of the Infant Rat (Dr B Mosinger, Z Placer and O Koldovsky), 1245
Passage of Lymphocytic Cells through Cellulose Membrane Filters Relation of Invasive Capacity to (Dr Emma Shelton and Dr Mary E Rice), 479
Passive Immunity in an Insectivore Transmission of (B Morris), 1151
Passive Sensitization (*in vitro*), of Isolated Plain Muscles with Precipitating Antibody Promoting Effect of Urea on the (R Binaghi, Dr B N Halpern, P Liacopoulos and T Neveu), 1805
Paste Transducers Ultrasonic Barium Titanate Adhesion and (Dr A Lutsch), 1458
Pasture Œstrogens in (J L van Haaften), 1575
Patat, F Macromolecules (Osmotic Pressure Techniques and Results), 1689
Pate, Dr J S Appointed lecturer in botany at Queen's University, Belfast, 322
Patella aspera Lamarck, New to Norway (Knut Kolstad), 1886
Patents and Development, Ltd (Canadian) Forty-second Annual Report of the National Research Council of Canada (1958-59), including the Annual Report of, 1916
Paterson, W G Awarded a Canadian Fellowship in Chemistry for 1959-60 by the Ramsay Memorial Fellowships Trustees, B A 16
Pathogenic Agent of Tyzzer's Disease of Mice Pure Culture of the (Dr K Kanazawa and A Imai), 1810
Pathogenic Factors in the Rooting Space and the Development of Even-Aged Plantations (W R Day), B A 46
Pathogenic *Fusarium oxysporum* Production of a Perfect Stage in a Nutritionally Deficient Mutart of, after Ultra-violet Irradiation (E W Buxton), 1258
Pathogenic *Xanthomonas* spp (Plant) Some New Specific Bacteriophages for (Z Klement), 1248
Pathogenic and Non-Pathogenic Fungi Human Precipitins against Common (Dr J Pepys, Dr R W Riddell and Dr Y M Clayton), 1328
Pathogenicity Test (A Rapid and Simple), for Detecting Virulent Clones of *Fusarium oxysporum* f *cubense* using Seedlings of *Musa balbisiana* (Dr R H Stover), 1591
Pathophysiological Effects of Circulating Ferritin (Yoshio Oki), 1944
Pathway of Carbon-^{14} Incorporation from $NaH^{14}CO_3$ to Haem in Duck Blood incubated *in vitro* (A Breccia, A L Fantola, E Lazzarini and A Giustina), 1879
Patients Radiological Hazards to—Interim Report of the Committee (Ministry of Health and the Department of Health for Scotland), 162
Patients with Bone Fractures Urinary β-Glucuronidase Activity in (F J W Lewis and Dr Constance H J Plaice), 1249
Paton, Dr A M Enhancement of Pigment Production by Pseudomonas, 1254
Patrick, Dr C R Gas Chromatography (Problems attached to 'Scaling-up' Analytical Columns), 1199
Pattabhiraman, T N, and Bachhawat, B K Biochemical Research in India (Purification and Properties of Glutamic–Oxalacetic Transaminase from Ox Brain and from Human Brain), 1368
Pattern (Cyclic Growth), in *Neurospora* Genetic Control of a (Growth Patterns in *Neurospora*), (Dr D R Stadler), 170
Pattern (Electron Diffraction) Structure of Precipitated Cadmium Sulphide as studied by Single-Crystal (Dr Ryoitiro Sato), 2005
Pattern Haemoglobin), of the Cyclostome *Pertromyzon planeri* during the Course of Development (M Adinolfi, G Chieffi and M Siniscalco), 1325
Pattern (Sex Chromatin), in the Male Rat Effect of Sexual Maturation and Castration on the (St Zsifkovits, Ch Mehes and C Jobst), 1239
Pattern (X-Ray Diffraction), of Carbide in Low-Carbon Iron-Silicon Alloys (G Konoval, L Zwell, L A Gorman and W C Leslie), 1862
Pattern and Control of Sclereid Formation in the Leaf of *Camellia japonica* (Donald E Foard), 1663
Patterns of Discovery (Prof Norwood Russell Hanson), *review* by Gerd Buchdahl, 572
Patterns (Behaviour), in a Hemileucine Moth Central Control of Interactions between (Dr A D Blest), 1164
Patterns (Blood Velocity) Intravascular and Intracardiac, recorded by means of *NTC* Resistors (Dr W G Zijlstra, J R Brunsting and L B v d Slikke), 991
Patterns (Growth), in *Neurospora*—A Biological Clock in *Neurospora* (C S Puttendrigh, Dr V G Bruce, N S Rosensweig and M L Rubin), 169, Genetic Control of a Cyclic Growth Pattern in *Neurospora* (Dr D R Stadler), 170
Patterns (Paper Electrophoretic), obtained by Paraffin-Oil Fixation (H Waldmann-Meyer), 1567
Patterns (Starch Gel Electrophoretic) Localization of Haemocyanin on (J R Whittaker), 193
Patterson, A, and Ettinger, R Fast Chemical Reations in Solution (Carbon Dioxide–Water Equilibrium, using Nuclear Magnetic Resonance Methods), 1453
Patterson, W Bradford (edited by) Wound Healing and Tissue Repair (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Patwardhan, Dr V N Biochemical Research in India (Mode of Action of Vitamin D), 1367
Paul, Dr E B Détecteurs de Particules (Compteurs et Scintillateurs) Mécanisme et Réalisation, *review*, 1977

Paul, Dr John Cell and Organ Culture (Recent Technical Advances in Cell Culture), 935
  Cell and Tissue Culture, *review* by Dr I Leslie, 1009
Paul Instrument Fund Awards, 507
Paulian, Dr Renaud A Zoological Survey of Madagascar, 1387
Pauly, Dr Helmut X-Ray Sensitivity and Target Volume of Enzyme Induction, 1570
Pauson, Dr P L Appointed to the chair of chemistry in the Royal College of Science and Technology, Glasgow, 233 , work of, 233
  Title of reader in organic chemistry in the University of Sheffield conferred on, 684
Pav, Dr J (Wenkeova, Dr J , and) Release of Non-Esterified Fatty Acids from Adipose Tissue in Normal and Diabetic Rats, 1147
Pavlichenko, Vladimir P , and others Statement on Biological and Chemical Warfare, 1018
Pawlowski, B Origin and Dispersal of Flowering Plants (Survivors of an Endemic Tertiary Flora on the east and west of the Carpathians), 1200
Pawlowsky, Prof E N Elected a member of the Zoology Section of the Leopoldina Academy of Natural Sciences, 595
Pawstiks, Dr E A , and Grutzov, Dr L N Polar Front Survey (Biology—Distribution of Plankton in the Norwegian Sea), 1183
Payak, Dr M M '*LO*-Analysis' as an Aid in the Study of Fungal Spore Morphology, 738
Payen, P (Boyer, A F , and) Coal Science (Carbonization—Apparent Exothermic Peak found in Differential Thermal Analysis of certain Coals), 413
Payen, P (Ladam, A , and) Coal Science (Ultra-fine Structure of Coals and Chars—Sorption of Pyridine by Carbonization Products), 413
Payne, L N (Biggs, P M , and) Cytological Identification of Proliferating Donor Cells in Chick Embryos injected with Adult Chicken Blood, 1594
Paywa, D K (Modi, Dr V V , and) Biosynthesis of Carotenes in Carrot Extracts, 983
Pea and Wheat Embryos Fine Structure in Cells of (G Setterfield, H Stern and F B Johnston), 505
Peach Seeds Gibberellic Acid and the Chilling Requirements of (the late Prof Margaretha G Mes), 2034
Peacock, F C Dagger Nematodes associated with a Clover Sickness, 123
Pearce, Prof James W (Chapman, Prof Kent M , and) Vagal Afferents in the Monkey, 1237
Pearce, Dr Louise *Obituary* by Dr J D Fulton, 588
Pearce, S C Loss of Information brought about by Loss of Data, 1826
Pearsall, Prof W H Conservation in the Scottish Highlands (Problems of Conservation in the Highlands), 1529
Pearson, D J Awarded a Perkin Centenary Scholarship, 237
Pearson, E O , assisted by R C Maxwell Darling The Insect Pests of Cotton in Tropical Africa, *review* by Dr W E China, 1011
Pearson, J A , and others Oxidation of Krebs Cycle Acids by Apple Tissue, 506
Pearson, Dr M C Coast Erosion and Accretion (Biology of the Sea Buckthorn, *Hippophae rhamnoides*), 500
Pearson, R G Fast Chemical Reactions in Solution (Paramagnetic Ions in Solution), 1453
Pearson, Dr W B A Handbook of Lattice Spacings and Structures of Metals and Alloys *review* by Dr J A Catterall, 841
Peas A Chemical Effect of Ethylene during the Storage of (Prof Frank A Lee), 462
Peat, Prof S Steric Aspects of the Chemistry and Biochemistry of Natural Products, 948
Peats (Ombrogenous) Occurrence of *Schoenus nigricans* L on (D J Bellamy), 1590
Peel, A J , and Weatherley, Dr P E Composition of Sieve-Tube Sap, 1955
Pegge, C Denis Instructional Film Research in Pennsylvania, 866
Peierls, Prof R E The Graduate School in Mathematical Physics at Birmingham, 96
  Awarded a Royal Medal for 1959 of the Royal Society, 1360, 1833 , work of, 1833
Peirson, D H , and Salmon, L Gamma Radiation from Deposited Fall-Out, 1678
Pejaudier, L (Steinbach, Marion, and) The Behaviour of Haptoglobin during Routine Fractionation, 362
Pelc, Dr S R Cell and Organ Culture (Application of Cell and Organ Culture in Cancer Research), 937
  Influence of Sexual Stimulation on the Metabolic Activity of Deoxyribonucleic Acid in the Seminal Vesicle, 1414
Pelentane or Thromexane (the Anti-coagulant Drug) Isomeric O-Methyl Ethers of Ethyl di-(4-hydroxycoumarinyl-3)-Acetate (Dr Eduard Knobloch), 1568
Pelham, Dr R A Title of senior lecturer in geography at the University of Southampton conferred on, 595
Pellegrino-Iraldi, Amanda A , and others The C_{17}-OH Group of Œstradiol—Relationships between its Anti-Atherogenic and Endocrine Actions, 1720
Pellerin, P , and others Low-Temperature Autoradiography for the Detection of Tritium in Tissue, with Removal of Luminescence induced by Tritium, 1385
Pellets (Cobaltic Oxide) Effect of, on the Vitamin B_{12} Content of Ewes' Milk (L I Hart and E D Andrews), 1242
Pelling, G Chromosomal Synthesis of Ribonucleic Acid as shown by Incorporation of Uridine labelled with Tritium, 655
Peluchon, G Polar Front Survey (Hydrography—French Observations in the North Atlantic and Davis Strait), 1182
Pemberton, Dr R T Life-Cycle of *Cyathostoma lari*, Blanchard 1849 (Nematoda, Strongyloidea), 1423
Pempidine Congeners of, with High Ganglion-blocking Activity (L Bretherick, G E Lee, E Lunt, W R Wragg and N D Edge), 1707
  Effect of, on the *in vitro* Synthesis of Acetylcholine (Joan Parkinson), 554
Penetration of the Liver-fluke, *Fasciola hepatica*, into the Snail, *Limnaea truncatula* (Dr Ben Dawes), 1334
Penfold, J Appointed to a United States Rubber Co research studentship at University College of North Staffordshire, 322
Penguin (New Fossil), from Australia (G G Simpson), 1612
Penicillin Lowered Bactericidal Efficiency of Hydrogen Peroxide on Milk from Cows treated with (J Babad, D L Boros and F Baier), 292
Penicillium chrysogenum Inhibitory Effect of Fungistatic Antibiotics on the Production of Amylase by (Dr I Horvath and A Szentirmai), 57
Penicillium chrysogenum (the Filamentous Mould), and the Control of its Morphology Continuous-Flow Culture of (S J Pirt and D S Callow), 307
Pennington, Dr W (Mrs T G Tutin) Relict Fauna of Ennerdale Water—a Problem Distribution, 1421
Pennsylvania Instructional Film Research in (C Denis Pegge), 866
Penny, R H C Lectureship in chemical pathology (veterinary) in the University of Bristol conferred on, 410
Penrice, T W Special Ceramics (Use of a Reversible Gel as a Mould Material giving substantially True Hydrostatic Pressures up to 50 tons/in^2), 1117
Pentachlorocyclohexene as a Possible Intermediate Metabolite of Benzene Hexachloride in Houseflies (R G Bridges), 1337
Pentelow, F T K River Purification, 94
Pentose Phosphate Metabolism (Dr D P Burma), 1368
Pentosuria Essential—Renal or Enzymic Disorder (Dr R C Bozian and Prof Oscar Touster), 463
Penttinen Dr Kari, and Saxen, Dr Erkki Growth-Controlling Action of Human Serum in Cell Culture, 1570
People Numbers of, *review* by Dr B Benjamin, 1521
Peoples (South African) Haptoglobin and Transferrin Variants in Bushmen and some other (Dr N A Barnicot, J P Garlick, Ronald Singer and Dr J S Weiner), 2042
Peover, Dr M E (Given, Dr P H , and) Hydrogenolysis of Carbon-Oxygen Bonds in some Aromatic Compounds by Electrolysis, 1064
Pepper, Dr Florence J Awarded a Research Fellowship in zoology in the University of Birmingham, 1688
Peptide (Nucleotide–) Compounds of *Saccharomyces cerevisiae* (G Harris and J W Davies), 788
Peptide (Phosphatido-) Fraction of Pancreas Slices Effect of Acetylcholine on the Incorporation of Radiophosphorus into the (Prof C G Huggins), 1412
Peptide Sequence (Terminal), of Human Haemoglobin ? (Dr J A Hunt and Dr V M Ingram), 640
Peptide-Substrates (O-Phosphorylated and Unphosphorylated), suitable for Tryptic Action (Dr D Theodoropoulos, H Bennich and Prof O Mellander), 270
Peptides with Oxytocic and Pressor Activity obtained from Acidified Rat Serum (Prof H Croxatto, T Pereda and R Mellada), 1496
Peptides (Amino-Acids and) . A Two-Dimensional System for the Separation of, on Paper (Virginia Richmond and Brian S Hartley), 1869
Peptides (Protein-bound), as exemplified by Oxytocin and Vasopressin Gel Filtration as a Method for Purification of (E B Lindner, Dr A Elmqvist and Dr J Porath), 1565
Peptides and Proteins Action of Anhydrous Formic Acid on (H Kienhuis, G Blasse and J Matze), 2015
Pepys, Dr J Delayed Hypersensitivity (Characteristic Delay in the Development of the Tuberculin Reaction), 1029
Pepys, Dr J , and others Human Precipitins against Common Pathogenic and Non-Pathogenic Fungi, 1328
Percentages (Small), of Foetal Haemoglobin Estimation of (Prof K Betke, H R Marti and I Schlicht), 1877
Perception A Mathematical Model for, and a Theoretical Confusion Function (M Hammerton), 1668
Perception (Olfactory) Discrimination between Ebb and Flood Tide in Migrating Elvers (*Anguilla vulgaris* Turt) by means of (F Creutzberg), 1961
Perception, Attention and Consciousness (Prof Magdalen D Vernon), B A 45
Perception and Learning, *review* by Prof O L Zangwill, 1523
Perception (Extra-Sensory) Experimental Evidence for (C M Hansel), 1515
Perception of Visual Space Possible Rôle of Higher Proprioceptive Centres in the, and in the Control of Motor Behaviour (Dr B Gurevitch), 1219
Perchonok, E Chemistry of Propellants (Air-Burning Fuels—Performance Evaluation), 779
Percival, Prof E *Obituary* by Elliot W Dawson, 403
Pereda, T , and others Peptides with Oxytocic and Pressor Activity obtained from Acidified Rat Serum, 1496
Perera, A Appointed chairman of the Executive Council of the Commonwealth Agricultural Bureaux, 943
Pereira, Dr H C A Physical Basis for Land Use Policy in Tropical Catchment Areas 1768
Perfect Stage Production of a, in a Nutritionally Deficient Mutant of Pathogenic *Fusarium oxysporum* after Ultra-violet Irradiation (E W Buxton), 1258
Perfused Rat Spleen (Isolated and) Production of γ- and α-Globulins by the (Dr E Espinosa), 1801
Pergamon Press To provide the funds for the *Talanta* Medal, 956
Period (Latent), of X-Ray Induced Ageing Study based on Mortality Rate and Tumour Incidence (Dr H I Kohn and Dr P H Guttman), 735
Periodate Technique for the Identification of Sugar Phosphates (Eugene A Davidson), 1395
Periodic Acid-Schiff-Positive Material and Alkaline Phosphatase in the Uterine Wall of the Pig during the Sexual Cycle (Rolv Austad and Dr Otto Garm), 999
Periodic Classification of Elements (A A Clifford), 2012
Periodic Law (D I Mendeleieff), edited by B M Kedrov (Russian Text), *review* by Prof S I Tomkeieff, 1598
Periodicals (British Books and) Exhibition in Moscow of (British Council and the Soviet Ministry of Culture), 1361
Peripheral Effect of the Bromide Ion on the Contraction of Striated Muscle (Dr D K de Jongh and H A Linnewiel), 1240
Peristaltic Reflex Are Mucosal Nerve Fibres Essential for the (Dr K H Ginzel), 1235
Perkin Centenary Trust Awards, 237
  Programme of Awards for 1960-61, 856
Perkins, Donald F (Goodman, Gordon T , and) Mineral Uptake and Retention in Cotton-Grass (*Eriophorum vaginatum* L), 467, *erratum*, 1845
Perkins, H R (Rogers, H J , and) Cell-Wall Mucopeptides of *Staphylococcus aureus* and *Micrococcus lysodeikticus*, 520

Perkins, W J Electronics in Biology, *review*, B A 4
Permanent Gases Analysis of, by Gas Chromatography using a Radioactive Ionization Type Detector (V Willis), 894
Permanent Moisture Expansion of Clay Products on Natural Exposure (J S Hosking and H V Hueber), 1373
Permanent Set, Supercontraction, and Urea-Bisulphite Solubility—the Proton-Transfer Nature of some Changes in Keratin and the Analogy with Muscle Contraction (Dr P T Speakman), 339
Permanganate (Lithium) Szilard-Chalmers Reaction in (J R Bolton and Prof K J McCallum), 1717
Permeability of Human Red Cells Calcium Ions and the (Prof M Maizels), 366
Permeability (Increased Capillary) Pharmacological Suppression of, following Irradiation of the Intestine of Rats (Dr D A Willoughby), 1156
Permutit Co, Ltd Portable 'Deminrolit' Plants for Distilled Water, 25
Peroxidase Histological Localization of (D S Van Fleet), 506
Peroxidase-Oxidase (Tryptophan), in *Drosophila melanogaster* Genetic Control of (Corrado Baglioni), 1084
Peroxidase-Oxidase (Tryptophan) Enzyme System Specificity of the (Dr R H Marchant), 1711
Peroxidation (Lipide), in Tissues Deficient in Vitamin E An Effect of Selenium and Cystine on (Dr John G Bieri), 1148
Peroxide (Hydrogen) Lowered Bactericidal Efficiency of, on Milk from Cows treated with Penicillin (J Babad, D L Boros and F Baier), 292
Peroxide (Hydrogen), H_2O_4? A Higher (Dr J G Marshall and Dr P V Rutledge), 2013
Peroxide (Hydrogen), and Ferric Salts Oxidation of Ethyl Alcohol by a Mixture of (Dr Mordechai L Kremer), 720
Perret, R Thermodynamics (Experimental Thermochemistry), 1607
Perrin, Dr D D Histidine–Copper (II) Complexes, 1868
Perrin, Dr D D, and others Binding of Haem to Protein in Haemoglobin and Myoglobin, 1651
Perrin, Dr R M S Soils of Tanganyika, *review*, 1901
Perrone, J C, and others Electrophoretic Heterogeneity of Trypsin, 1225
Perry, Dr Robert P, and others Localization and Assay of Respiratory Enzymes in Single Living Cells—Absorbancy Measurements on the *Neberkern*, 929
Perry, Dr S V Appointed professor of biochemistry in the University of Birmingham, 679, work of, 679
Perry, Dr Thomas L, and others Urinary Excretion of β-Amino-isobutyric Acid in Mongolism, 1970
Perry, W E *Obituary*, 151
Personnel Scientific and Technical (United States National Science Foundation to establish and maintain a Programme of National Information on), 592
Personnel Management, Institute of Staff in Industry and Commerce—Management of Workers whose Skills are mainly Mental or Social rather than Manual (E M Barling), 319
  Management Development—a Systematic Approach to the Provision of Supervisors and Managers (F I de la P Garforth), 319
  Annual Conference (Personnel Management and Technological Change), 1614
Personnel Management and Technological Change (Institute of Personnel Management Annual Conference), 1614
Perspectives in Marine Biology, a Symposium held at Scripps Institution of Oceanography, 1956 (edited by A A Buzzati-Traverso), *review* by Dr J A Allen, 215
Perspectives in Virology—a Symposium (edited by Morris Pollard), *review* by N W Pirie, 920
Pertromyzon planeri Haemoglobin Pattern of the Cyclostome, during the Course of Development (M Adinolfi, G Chieffi and M Siniscalco), 1325
Peru Flora of (Rogers McVaugh), *review*, 666
  Orchids of (C Schweinfurth), 409
Perus (Fische), II Beitrage zur Kenntnis der (Dr Hans-Wilhelm Koepche), (Beiträge zur Neotropischen Fauna), *review* by Dr F A Turk, 1177
Pest Control, 941
Pest Control Research Advances in (edited by R L Metcalfe), Vol 2, *review* by F C Bawden, 1258
Pests of Farm Crops Recognition of Diseases and (Ernst Gram, Prosper Bovien and Chr Stapel), *review* by F C Bawden, 1258
Pests (Insect), of Cotton in Tropical Africa (E O Pearson, assisted by R C Maxwell Darling), *review* by Dr W E China, 1011
Pests (New), of Cocoa (*Theobroma cacao* L) in Ghana following Applications of Insecticides (P F Entwistle, C G Johnson and E Dunn), 2040
Pests and Diseases Biological Problems arising from the Control of (Institute of Biology Symposium on), 1100
Pests and Diseases in Agricultural and Horticultural Crops Control of (G L Hey and K Marshall), *review* by F C Bawden, 1258
Petals (Flower), of *Adonis annua* L Occurrence of Astaxanthin in the (A Seybold and Prof T W Goodwin), 1714
Petch, N J Atomic Mechanisms of Fracture (Metallurgical Aspects of Cleavage), 325
Peters, Sir Rudolph Enzymes (Enzyme Inhibitors), 687
Petragnani, Nicola, and others Methaemoglobin Reduction through Cytochrome B_5, 1651
Petrobius maritimus Leach Composition of the Haemolymph of (Dr A P M Lockwood and Dr P C Croghan), 370
Petrographie Precis de (Prof Jean Jung), *review* by J C M Taylor, 1677
Petroleum Catalytic Processes and, *review* by Dr David M Wilson, 1090
  The Future of Chemicals from (L H Williams), 1915
Petroleum, Institute of (Gas Chromatography Discussion Group and the Hydrocarbon Research Group) Completion of the reorganization of the, 327
  Symposium on Gas Chromatogtaphy, 327
  Honorary life membership conferred on Dr A J P Martin, 327
Petroleum Engineers (Mining, Metallurgical and), American Institute of (Metallurgical Society of the) New series of books entitled Metallurgical Society Conferences, 1362
Petroleum Industry Centenary of the, 1611
  Handbook of the (edited by G Sell and H A Dossett), *review*, 1832
Petroleum Industry (United Kingdom), Statistics relating to Consumption and Refinery Production, 1957 and 1958 (Petroleum Information Bureau), 855
Petroleum Information Bureau United Kingdom Petroleum Industry Statistics relating to Consumption and Refinery Production, 1957 and 1958, 855
Pettersson, Dr Max Main Stages of Social Evolution in Man, 481
  Diffusion of a New Habit among Greenfinches, 649
Petty, J H P, and others Extended Dormancy of Deciduous Woody Plants treated in Autumn with Gibberellic Acid, 69
Peus, Prof Fritz Elected a member of the Zoology Section of the Leopoldina Academy of Natural Sciences, 595
Peyssou, J Special Ceramics (Possible Variations of Properties of Ceramic Articles caused by Variations in Firing Conditions and Methods of Manufacture), 1117
Pfeiffer, Dr H H Flow Properties of Biological Systems (Measurements of Rheodichroism), 1540
Pfeil, P C L (Griffiths, L B, and) Insulating Particles on Cathode Surfaces—their Effect upon Electrical Discharges, 1475
*p*H Relationship of, to Aerobic Corrosion Fatigue Life of Steel (Dr Frederick J Radd, L Hugh Crowder and Louis H Wolfe), 2008
*p*H and Volatile Fatty Acid Relationship between, and Diversion of Saliva from the Actively Fermenting Rumen of Sheep (W R McManus), 1572
*p*H Meter Analytical Pocket (Analytical Measurements, Ltd), 683
Phage Formation Induction of, in the Lysogenic *Escherichia coli* K-12 by Mitomycin C (Dr Nozomu Otsuji, Dr Mutsuo Sekiguchi, Dr Teiji Iijima and Dr Yasuyuki Takagi), 1079
Phages (Type-determining), of *Salmonella typhi* Mutation in the (E S Anderson), 1822
Phagocytic Activity of the Macrophage System Assessment of the (Dr D L J Bilbey and Dr H. Salem), 992
  Influence of Sulphur Dioxide Inhalation on the (Prof D L J Bilbey and Dr H Salem), 722
Phagocytic Activity of the Reticulo-Endothelial System Effect of Sulphonamides on the (Prof T Nicol and I A Sewell), 1241
Phalaris Staggers Blood Acetylcholinesterase in (Dr D J Walker), 1411
Phanomenologischen Reduktion Theorie der (Erste Philosophie, 1923-24 (Edmund Husserl), Teil 2), herausgegeben von Rudolf Boehm (Husserliana, Band 8), *review* by F I G Rawlins, 1751
Pharmaceutical Research Soviet, Vol 1, Pharmaceutical Chemistry, Vol 2, Pharmacognosy, Vol 3, Medicinal Chemistry, *review* by Dr D Train, 1831
Pharmaceutical Research in the U S S R, *review* by Dr D Train, 1831
Pharmaceutical Society of Great Britain Tribute paid to its founder, Jacob Bell, on the hundredth anniversary of his death (Gwilym Hughes), 23
  Appointment of Gwilym Hughes as president, 95
Pharmacological Effects of Staphylolysin on the Isolated Rat Uterus Some (Dr B Wiegershausen), 2017
Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates (Active Principles of the Neurohypophysis of Cold-blooded Vertebrates), (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464
Pharmacological Suppression of Increased Capillary Permeability following Irradiation of the Intestine of Rats (Dr D A Willoughby), 1156
Pharmacology Annual Review of, 943
Pharmacology of 16-Acetyl Digitalinum Verum Chemistry and (Z Kanda, Prof A Sekiya K Katayama, A Okano and T Miki), 1414
Pharmacology of Plant Phenolics—Proceedings of a Symposium held at Oxford, 1958 (edited by J W Fairbairn), *review* by Dr F A Robinson, 486
Pharmacy as a Career (Central Youth Employment Executive), 95
Phase Systems (Aqueous Polymer) Counter-Current Distribution of Proteins in (Per-Ake Ålbertsson and Ed Jacques Nyns), 1465, *erratum*, 1688
Phase Transitions in Interlamellar Films (Dr D M C MacEwan and Dr F Aragon de la Cruz), 1859
Phaseolus vulgaris (Bean) Hypocotyls Influence of Kinetin, β-Indoleacetic Acid and Gibberellic Acid on Nuclease Activity of (Dr W Maciejewska-Potapczyk), 557
Phenazine Di-*N*-Oxide as a Carcinostatic Agent (Arthur Furst, Claire Klausner and Windsor C Cutting), 908
Phenazocine, a Potent New Analgesic Identification of (Dr E G C Clarke), 451
Phenol Effect of Flavins on Cramp caused by (Prof Kunio Yagi, Dr Hirofumi Yagi and Dr Ikuko Nagatsu), 1648
Phenolic Œstrogens Two Enzymic Mechanisms for Hydrogen Transport by (Dr H G Williams-Ashman, M Cassman and Margaret Klavins), 427
Phenolics (Plant) The Pharmacology of—Proceedings of a Symposium held at Oxford, 1958 (edited by J W Fairbairn), *review* by Dr F A Robinson, 486
Phenols Colour Reactions of certain, with Ehrlich's Reagent (Dr Cornelius Steelink), 720
Phenols of Plant Origin Biological Properties of, *review* by Dr F A Robinson, 486
Phenomena Co-operative (Prof Lars Onsager), 1195
Phenomena occurring in Steels during Quenching and Tempering (Academician G V Kurdjumov), 1450
Phenomena (Fluctuating), in Semi-Conductors (Prof A Van der Ziel), *review* by Dr R A Hyman, 1754
Phenomena (Fluctuation), and Stochastic Processes (Physical Society Conference on), 509
Phenomena (Fractionation), in Nuclear Weapons Débris (K Edvarson, Kerstin Low and J Sisefsky), 1771
Phenomena (Geomagnetic), associated with Nuclear Explosions Some (Dr R G Mason and Dr M J Vitousek), B A 52
Phenomena (Geomagnetic and Ionospheric), associated with Nuclear Explosions (Dr S Matsushita), B A 33
Phenomena (Ionization), in Gases (J Dutton, D Harcombe and E Jones), 1353
Phenomena (Some New Subjective), apparently due to Interocular Transfer (Ian P Howard), 1516
Phenomena (Very Low Frequency), at Godhavn, Greenland Observations of 'Whistlers' and (Eigil Ungstrup), 806

Phenothiazine-Tranquillizers Differential Analysis of the Effects of, on Emotional and Motor Behaviour in Experimental Animals (Dr M Taeschler and Dr A Cerletti), 823
Phenoxy-Compounds (Substituted), and other Translocated Herbicides Effects of, on the Rhizome of Bracken (Dr Elsie Conway and J A Forrest), 1416
DL-beta-Phenylserine Influence of, on the Synthesis of Proteins in *Escherichia coli* (J Janeček, J Chaloupka, K Vereš and M Havranek), 1895
Philanthropic Foundations Grants for Private, during 1957 (United States National Science Foundation, Reviews of Data on Research and Development, No 15), 1272
Philips Electrical Industries Pty, Ltd Grant of £3,500 towards the cost of the third Summer School for Science Teachers of the Australian Nuclear Research Foundation, 1108
Phillips, C S G Gas Chromatography, 1199
Phillips, F T Effect of Emulsifiers and Organic Diluents in Soil Insecticide and Nematicide Formulations, 1512
Phillips, G C Awarded a Nature Conservancy Research Studentship for post-graduate training in ecology (zoology), 156
Phillips, Dr J G, and Mulrow, Dr P J Failure of Corpuscles of Stannius from Winter Flounder (*Pseudopleuronectes americanus*) to Synthesize Adrenocorticosteroids *in vitro*, 558
Phillips, Dr J N, and others Binding of Haem to Protein in Haemoglobin and Myoglobin, 1651
Phillips, J W, and others Compaction of Briquettes, 120
  Coal Science (Carbonization—Effect of Macerals on Volume Changes in Briquettes during Carbonization), 413
Phillips, Dr R Nuclear Forces and the Few-Nucleon Problem (Scattering of Nucleons by Light Nuclei at High Energy), 1113
Phillips Petroleum Co Foundation of a postgraduate research studentship at University College of North Staffordshire, 322
Philosophical Development My (Bertrand Russell), *review* by Prof R B Braithwaite, 749
Philosophical Society, American Transactions, New Series, Vol 48, Part 6, Preliminary Archaeological Investigations in the Sierra de Tamaulipas, Mexico (Dr Richard S MacNeish), 593
Philosophie Erste (1923-24), (Edmund Husserl), Teil 2, Theorie der Phänomenologischen Reduktion (herausgegeben von Rudolf Boehm), (Husserliana, Band 8), *review* by F I G Rawlins, 1571
Philosophy Science and (G E Denyer), 1193
Philosophy of Science History and (L W H Hull), *review* by Dr H D Anthony, 131
  Scientific Research and the (British Society for the Philosophy of Science Symposium on), 1193
Philosophy of Science, British Society for the Fourth Annual Conference, 1193
  Symposium on Scientific Research and the Philosophy of Science, 1193
  Symposium on Biology and Physics, 1193
  Symposium on Classification, Concept-formation and Language, 1193
  Symposium on Knowing and Being, 1193
Philosophy (Natural), and related Documents Papers and Letters on (Isaac Newton), edited with a General Introduction by I Bernard Cohen, assisted by Robert E Schofield, *review* by Dr M A Hoskin, 1570
Phoenix Re-born (Dr Maurice Burton), *review* by T H Hawkins, 665
Phosphatase (Acid and Alkaline) Visualization of, after Starch-Gel Electrophoresis of Seminal Plasma, Serum and Bile (Dr Bengt Estborn), 1636
Phosphatase (Alkaline) Periodic Acid-Schiff-Positive Material and, in the Uterine Wall of the Pig during the Sexual Cycle (Rolv Austad and Dr Otto Garm), 999
Phosphatases (Pituitary Acid), *in vitro* Effects of Methylthiouracil or Thyroidectomy on Activation of, by Whole Hypothalamic Extract (Dr V Schreiber and Dr V Kmentova), 728
Phosphate (Calcium) Purification of Herpes Simplex Virus by Chromatography of (Janice Taverne and Peter Wildy), 1655
Phosphate (l-Glyceryl-2-*myo*-inositol) Synthesis and Properties of (Dr T Malkin), 789 , Synthesis of l-Glyceryl-2-*myo*-inositol Phosphate (J H Davies and Dr T Malkin), 789 , l-Glyceryl-2-*myo*-inositol Phosphate —Alternative Synthesis and Behaviour on Hydrolysis (R B Ellis and J N Hawthorne), 790
Phosphate (Inorganic) Need for, in Oxidations stimulated by Dinitrophenol (P Borst and Prof E C Slater), 1396
Phosphate (Isotopically Exchangeable), in Soil Effect of the Level of Microbial Population on (Dr P Newbould and Dr R L Lucas), 1155
Phosphate (Pentose) Metabolism (Dr D P Burma), 1368
Phosphate (Polyphloretin) Effect of, on the Suspension Stability of Red Blood Corpuscles (Dr Bengt Fries), 62
Phosphate (Pyridoxal), a Coenzyme for Histidine Decarboxylase (S Ono and Prof P Hagen), 1143
Phosphate (L-Serine) Crystal Structure of (G H McCallum, Prof J Monteath Robertson and Dr G A Sim) 1863
Phosphates (Amino-acid), under Physiological Conditions Spontaneous De-amination of (Dr Mella Paecht and Prof A Katchalsky), 1489
Phosphates (Sugar) Periodate Technique for the Identification of (Eugene A Davidson), 1395
Phosphatidic Acid as the Sodium Carrier Evidence for (Dr Lowell E Hokin and Mabel R Hokin), 1068
Phosphatido-Peptide Fraction of Pancreas Slices Effect of Acetylcholine on the Incorporation of Radiophosphorus into the (Prof C G Huggins), 1412
Phosphide and Nitride (Boron) Synthesis of (Dr R C Vickery), 268
Phosphide (Zinc) Particles Absorption of (Dr A S Curry, Dr D E Price and Dr F G Tryhorn), 642
Phospholipid Phosphoric Esters in the Human Placenta (G Porcellati, B Curti and S Luciani), 1870
Phospholipids (Oilseed) Sterol Glycosides in (Dr Francis Aylward and B W Nichols), 1319
Phosphonic Acid (2-Aminoethane) Isolation of, from Rumen Protozoa (Masaaki Horiguchi and Makoto Kandatsu), 901
Phosphonitrilic Chlorides Polymerization of (Prof Thomas R Merton), 899
Phosphoric Esters (Phospholipid), in the Human Placenta (G Porcellati, B Curti and S Luciani), 1870
Phosphorus Chemistry of, *review* by Dr F G Mann, 389
Phosphorus and its Compounds (John R Van Wazer), Vol I, Chemistry, *review* by Dr F G Mann, 389
Phosphorus-32 Injected Intraperitoneally into Rats Fate of the Highly Polymerized Spleen Deoxyrobonucleic Acid labelled with (Tamara A Hudnik-Plevnik, Vladimir R Glišin and Marta M Simic), 1818
Phosphorus and Die-Back in Yellow Lupins High Levels of (R G Warren and B Benzian), 1588
Phosphorus Content of Forages A Method of Increasing the (Prof R Ferrando, S Metivier and R Gervy), 76
Phosphorus (Organic-) Compounds (Bradford Institute of Technology Symposium on), 1688
Phosphorus (Radioactive) An Effect of Dose Fractionation on the Incidence of Bone Tumours using (Dr N M Blackett), 565
Phosphorylase (Polynucleotide), in Atypical Epithelioma of Rat Occurrence of (Dr Kunio Yagi, Takayuki Ozawa and Hiroshi Konogi), 1939
O-Phosphorylated Analogue Action of Trypsin on α-Carbethoxy-L-lysyl-L-serylglycine and its (Dr D Theodoropoulos, H Bennich, G Folsch and Prof O Mellander), 187
O-Phosphorylated and Unphosphorylated Peptide-Substrates suitable for Tryptic Action (Dr D Theodoropoulos, H Bennich and Prof O Mellander), 270
Phosphorylation Excitability and, of Muscle and Nerve in Sodium-free Hydrazinium Solution (L G Abood and K Koketsu), 725
Phosphorylation (Oxidative) Protein Synthesis and, in Isolated Rat Liver Mitochondria (P J Reis, J L Coote and T S Work), 165
Phosphorylation (Oxidative), in *Azotobacter vinelandii* Fractionation of the System bringing about (H G Hovenkamp), 471
Phosphorylation (Oxidative), in Guinea Pig Heart Sarcosomes Reversal by Acetylcholine of the Inhibition by Thyroxine of (Heitor Medina and Metry Bacila), 1066
Phosphorylations (Mitochondrial Oxidative), in Intact Ascites Tumour Cells Effiicency of the (Dr P Emmelot and C J Bos), 2024
Phosphorylative Activities (Oxidative and), of Cytoplasmic Particles from Plant Tissue Cultures (Taiki Tamaoki, Prof A C Hildebrandt, A J Riker, R H Burris and Bunji Hagihara), 1491
Photoautomerization of Cytosine Derivatives on Ultra-violet Irradiation (Shih Yi Wang), 184
Photobiology Group Election of Dr D Vince as honorary secretary, 1362
Photo-bleaching (Reductive) Effect of Added Substances on the Rate of (Reductive Photo-bleaching of Eosine), (Kengo Uchida, Shunji Kato and Masao Koizumi), 1620
Photo-bleaching (Reductive), of Eosine—Primary Processes indicated by the Flash Technique (Shunji Kato and Masao Koizumi), 1620 , Effect of Added Substances on the Rate of Reductive Photo-bleaching (Kengo Uchida, Shunji Kato and Masao Koizumi), 1620
Photochemical Behaviour of Retinene (Photochemical and Stereochemical Properties of Carotenoids at Low Temperatures), (Dr Lawrence Jurkowitz), 614
Photochemical and Stereochemical Properties of Carotenoids at Low Temperatures (Staff of the Biological Laboratories of Harvard University)—Photochemical Behaviour of Retinene (Dr Lawrence Jurkowitz), 614 , *Cis-trans* Isomerism and Steric Hindrance (John N Loeb, Paul K Brown and Prof George Wald), 617 , Discussion (Prof George Wald), 620
Photographic Society, Royal (Scientific and Technical Group) Symposium on Photography in the International Geophysical Year, 1032
Photographs (Aerial), of Quarries and Mines Exhibition of (Geological Museum, London), 855
Photographs (Lyman-Alpha), of the Sun (J D Purcell, Dr D M Packer and Dr R Tousey), 8
Photography in the International Geophysical Year (Scientific and Technical Group of the Royal Photographic Society Symposium on), 1032
Photography (Colour) Kodak Scholarships in, 1915
Photography (Colour), of the Aurora (B P Sandford and P Heiser), 540
Photolysis of Thionine in Rigid Medium—Measurement by Spectrofluorimetry (Dr C A Parker and W T Rees), 1223
Photometric Methods Colorimetric Methods of Analysis, including (Dr Foster Dee Snell and Dr Cornelia T Snell, assisted by Dr Chester Arthur Snell), Vol 2A, *review* by J King 1522
Photomicrography (Dr Roy M Allen), second edition, *review* by Dr S Bradbury, 1174
  Applied Microscopy and (H M Malies), *review* by Dr S Bradbury, 1174
  Microscopes and, *review* by Dr S Bradbury, 1174
Photon Correlation Polarization and Resolving Time Effects in (Dr E Brannen and Prof W Wehlau), 263
Photon Streams Fluctuations in (Dr Peter Fellgett, Dr R Clark Jones and Dr R Q Twiss), 967 , (Dr C W McCombie), 969
Photoperiod Effect of, on the Gonadal Cycle in an Equatorial Bird, *Quelea quelea* (Dr Albert Wolfson and David P Winchester), 1658
  Influence of Gibberellic Acid and, on the Growth, Flowering, Nodulation and Nitrogen Assimilation of *Vicia villosa* (the late Prof Margaretha G Mes), 2035
Photoperiodic Reaction in the Genus *Chenopodium* (Tourn) L Extreme Sensitivity of Germination and (Dr Bruce G Cumming), 1044
Photophosphorylation and the Hill Reaction Relationship between (Dr H E Davenport), 524
Photopositive Domination in a Scolytid Beetle Release by Flight Exercise of a Chemotropic Response from (Prof Kenneth Graham), 283
Photoreactive Pigments in Flagellates—Chromoprotein Pigments of some Cryptomonad Flagellates (Dr Mary Belle Allen, Dr Ellsworth C Dougherty and Dr John J A McLaughlin), 1047 , Phycoerythrins and Phycocyanins of Cryptomonads (Dr C OhEocha and M Raftery), 1049 , Photosynthetically Active Accessory Pigments of Cryptomonads (Dr F T Haxo and D C Fork), 1051
Photosynthetic Bacteria Function of Carotenoids in (Prof M Dworkin), 1891
Photosynthesis Conversion of Light into Chemical Energy in (Prof David I Arnon), 10, *errata*, 1613
Photosynthesis in the Ear of Barley (Prof A Frey-Wyssling and Dr M S Buttrose), 2031
Photosynthetically Active Accessory Pigments of Cryptomonads (Photoreactive Pigments in Flagellates), (Dr F T Haxo and D C Fork), 1051
Phycocyanins of Cryptomonads Phycoerythrins and (Photoreactive Pigments of Flagellates), (Dr C OhEocha and M Raftery), 1049

Phycoerythrins and Phycocyanins of Cryptomonads (Photoreactive Pigments in Flagellates), (Dr C OhEocha and M Raftery), 1049
Phycology in Britain, 1534
Phycomyces Sporangiophores Gallic Acid in (David S Dennison), 2036
Phylogeny of the Genus *Aniba* Aubl —a Comparative Morphological and Chemical Observation (Walter B Mors, Otto Richard Gottlieb and Ida de Vattimo), 1589
Physalia Dimorphism and Size Distribution in *Velella* and (Prof Robert Bieri), 1333
Physical Basis for Land Use Policy in Tropical Catchment Areas (Dr H C Pereira), 1768
Physical Metallurgy of Magnesium and its Alloys (Prof G V Raynor), *review* by Dr J W Martin, 486
Physical Properties of Materials Relationship between Structure and (Non-Destructive Testing Group of the Institute of Physics and the Société Française de Métallurgie Discussion on), 1688
Physical Properties of Mucin Molecular Shape and the (R A Gibbons), 610
Physical Properties (Biological and) Turnip Yellow Mosaic Virus Nucleoprotein Particles with differing (R E F Matthews), 530
Physical Society Annual General Meeting, 419
  Presidential Address, Recent Trends in the Theory of the Ionosphere (J A Ratcliffe), 419
  Election of Officers, 420
  Conference on Fluctuation Phenomena and Stochastic Processes, 509
  1958 Year Book, 954
  Guthrie Lecture, Experimental Tests of Quantum Electrodynamics (Prof W E Lamb), 954
  Holweck Lecture, Spin Temperature (Prof A Abragam), 943
  Charles Chree Lecture (Sir Edward Bullard), 954
  Duddell Medal Address, Measurement of the Thickness of the Helium Film (Prof L C Jackson), 954
  Charles Vernon Boys Prize Address, Development of Bubble Chambers and some recent Bubble Chamber Results in Elementary Particle Physics (Dr D A Glaser), 954
  Conference on Thermonuclear Research, 1015
  Conference on Electron–Phonon Interaction in Solids, 1613
  Exhibition, 1688
Physical Society (Acoustics Group) Symposium on Recent Studies of Noise Problems, 414
Physical Society (Low Temperature Group) Institution of a Simon Memorial Prize, 1026
  First Simon Memorial Prize awarded to Dr Heinz London, 1026
Physical Society (Acoustics Group), and the Institute of Physics Symposium on New Techniques in the Analysis of Noise and Vibration, 415
Physical Theory of Neutron Chain Reactors (Alvin M Weinberg and Eugene P Wigner), *review* by Dr J Walker, 1973
Physical and Chromatographical Observations of γ-Irradiated Potato Starch Granules (Akira Mishina and Ziro Nikuni), 1867
Physicians of Philadelphia, College of Alvarenga Prize for 1959 awarded to Dr Hilary Koprowski, 683
Physics Applications of Statistics in, *review* by Dr H Steeple, 664
  Biology and (British Society for the Philosophy of Science Symposium on), 1193
  Crystal (British Association for the Advancement of Science, Section A (Mathematics and Physics), Discussion on), 596
  Elementary Statistical (Prof C Kittel), *review* by Dr G M Bell, 1178
  Handbook of (edited by Dr E U Condon and Dr Hugh Odishaw), *review* by Prof H Lipson and S G Lipson, 298
  Solid State (Australian Branch of the Institute of Physics Conference on), 1117
  Solid State (edited by Frederick Seitz and David Turnbull), Vols 4, 5 and 6, *review* by Prof E C Stoner, 1753
  Statistical (L D Landau and E M Lifshitz), translated from the Russian by E Peierls and R F Peierls, *review* by Dr H Steeple, 664
  Theoretical (Prof F Woodbridge Constant), *review* by Dr R M Tennent, 1832
  Turning Points in—a Series of Lectures given at Oxford University in Trinity Term, 1958 (Dr R J Blin-Stoyle, Dr D ter Haar, Dr K Mendelssohn, Prof G Temple, F Waismann and Prof D H Wilkinson), *review* by G R Noakes, 1090
Physics at the University College of North Staffordshire, 590
Physics, Institute of Notes for Authors, revised edition, 95
  Conference on Some Apsects of Magnetism, 322
  Thirty-ninth Annual Report (1958), 603
  Election of Officers, 604
  Conference on Structure Analysis and Experimental Techniques, 857
Physics, Institute of (London and Home Counties Branch) Symposium on the Design of Physics Research Laboratories (London, 1957), *review* by S Weintroub, 925
Physics, Institute of (Acoustics Group of the Physical Society and the) Symposium on New Techniques in the Analysis of Noise and Vibration, 415
Physics, Institute of (X-Ray Analysis Group) Conference on Biological Fibres, B A 25
  Discussion on Clay Minerals, 780
Physics, Institute of (Australian Branch) Conference on Solid State Physics, 1117
Physics, Institute of (Non-Destructive Testing Group), and the Societé Française de Métallurgie Discussion on the Relationship between Structure and Physical Properties of Materials, 1688
Physics of Elementary Particles (Prof J D Jackson), *review* by P T Matthews, 1677
Physics of the Solid Body (published in the Russian language by the Academy of Sciences of the U S S R), 410
Physics and Chemistry of Glasses (Society of Glass Technology), 855
Physics (Applied), at Durham, 1022
Physics (Biological and Medical) Advances in, Vol 6 (edited by Cornelius A Tobias and John H Lawrence), *review* by Dr N M Blackett, 1766
Physics (Electron) Advances in Electronics and (edited by L Marton, assisted by Claire Marton), Vol 10, *review* by J R Tillman, 1601
Physics (Electron), and Technology (Dr J Thomson and E B Callick), *review* by Dr D A Bell, 83
Physics (Elementary Particle) Development of Bubble Chambers and some recent Bubble Chamber Results in (Dr D A Glaser), 954
Physics (Health) Radiation Safety and (J W Lucas), 329
Physics (Low-Temperature) Experimental Techniques in (Guy Kendall White), *review* by Prof J F Allen, 1260
Physics (Mathematical), at Birmingham, 679
Physics (Mathematical), at Birmingham The Graduate School in (Prof R E Peierls), 96
Physics (Modern) Guide to, *review* by Prof H Lipson and S G Lipson, 298
  Principles of (Prof Robert B Leighton), *review* by Dr E Stanley, 1438
Physics (Nuclear), at the University of the Witwatersrand, 233
Physics (Nuclear), Development Commission on Biological (Non-Medical) Problems of (Agricultural Research Council, the Medical Research Council and the) Appointment of Sir James Denby Roberts as chairman of the Joint Committee of the, 237
Physics (Solid State) Aspects of, *review* by Prof E C Stoner, 1753
Physics (Theoretical), at Cambridge Applied Mathematics and, 686
Physics (Theoretical), at Sydney, 1447
Physics (Thermo-Nuclear), at Sydney, 1447
Physics Research, Brazilian Centre for Appeal by Unesco and the International Atomic Energy Agency for help to reconstruct the Library of the, 769
Physics Research Laboratories The Design of—a Symposium of the London and Home Counties Branch of the Institute of Physics (London, 1957), *review* by S Weintroub, 925
Physik Handbuch der (herausgegeben von S Flugge), Band 50, Astrophysik I, Sternoberflachen-Doppelsterne, *review* by Prof R O Redman, B A 3
Physikalische Chemie, Deutsche Bunsengesellschaft fur, and the Max-Planck Gesellschaft Colloquium on Fast Chemical Reactions in Solution, 1453
Physikalische Chemie, Deutsche Bunsengesellschadt fur, and the International Union of Pure and Applied Chemistry Symposium on Thermodynamics, 1606
Physiological Activity in Extracts of *Albizia* Species (A Lipton), 822
Physiological Anticoagulating System Interrelations between the Blood Coagulating System and the (Prof P A Kudrjashov), 454
Physiological Conditions Spontaneous De-amination of Amino-acid Phosphates under (Dr Mella Paecht and Prof A Katchalsky), 1489
Physiology Annual Review of (edited by Victor E Hall, in association with Frederick A Fuhrman and Arthur C Giese), Vol 21, *review* by Prof D C Harrison, 838
  Progress in, *review* by Prof D C Harrison, 838
Physiology at King's College, London 405
Physiology of Fungi (Prof Vincent W Cochrane), *review* by Dr J L Harley, 85
Physiology of Milk Secretion Potassium and Lactose in Milk in relation to the (Dr J A F Rook and Marian Wood), 647
Physiology (Cell), of Neoplasia (University of Texas Anderson Hospital and Tumour Institute fourteenth Annual Symposium on Fundamental Cancer Research), 1451
Physiology (Fungal) A Source Book of, *review* by Dr J L Harley, 85
Physique du Globe Realisation du Centre de, a Dourbes (Prof E Lahaye), 1022
Phytogeography and Geology Panbiogeography, or an Introductory Synthesis of Zoogeography, (Dr Léon Croizat), Vol 1, The New World, Vol 2a, The Old World , Vol 2b, The Old World (continuation), *review* by Prof Ronald Good, 924
Phytoplankton (Freshwater) Buoyancy in relation to the Ecology of the (Dr J W G Lund), 1534
π The Value of, and the Old Testament (Dr J Heading), 78
cio otto, Prof E (Gonfiantini, Dr R , and) Oxygen Isotope Variations in Antarctic Snow Samples, 1557
Pick, Jiří, and others Vapour–Liquid Equilibrium (translated by G Standart), *review* by Dr R Sargent, 837
Pickavance, T J At the Conference of the Mammal Society of the British Isles (Methods of carrying out Regional Mammal Surveys), 30
Pickering, B T , and Heller, Prof H Active Principles of the Neurohypophysis of Cold-blooded Vertebrates—Chromatographic and Biological Characteristics of Fish and Frog Neurohypophysial Extracts, 1463
Pickering, F B Appointed head of the Physical Metallurgy Section of the United Steel Companies, Ltd , 95
Pickering, Sir George White Elected an Honorary Member of the American Academy of Arts and Sciences, 410
Pickthall, J (Herzka, A , and) Pressurized Packaging (Aerosols), *review* by Dr V G W Harrison, 1437
Piddington, Dr J H Awarded the T K Sidey (Summertime) Award of the Royal Society of New Zealand, B A 16
  Awarded the David Syme Research Prize of the University of Melbourne, B A 16
Piel, Gerard Feeding the Hungry, 162
Pierce, R L (Grayson, J F , and) Origin and Dispersal of Flowering Plants (Low Representation of Angiosperms in two American Cretaceous Floras), 1201
Pieroni, Rômulo R (Lima, Fausto W , and) Paper Chromatographic Separation of Components of Rose Bengal Labelled with Iodine-131, 1065
Pig during the Sexual Cycle Periodic Acid-Schiff-Positive Material and Alkaline Phosphatase in the Uterine Wall of the (Rolv Austad and Dr Otto Garm), 999
Pig Kidney Tissue Culture Monolayers Effect of Proflavine on the Formation of the Virus of Foot-and-Mouth Disease and its Infective Ribonucleic Acid in (F Brown and Doreen L Stewart), B A 74
Piggott, W R The Calculation of the Median Sky Wave Field Strength in Tropical Regions, 605
Pigment Particles (Titanium Dioxide) Forces between (James E Latty and Dr W C Clark), 49
Pigment Production by Pseudomonas Enhancement of (Dr A M Paton), 1254
Pigments in Flagellates Photoreactive—Chromoprotein Pigments of some Cryptomonad Flagellates (Dr Mary Belle Allen, Dr Ellsworth C Dougherty and Dr John J A McLaughlin), 1047 , Phycoerythrins and Phycocyanins of Cryptomonads (Dr C OhEocha and M Raftery), 1049 , Photosynthetically Active Accessory Pigments of Cryptomonads (Dr F T Haxo and D C Fork), 1051

Pigments (Carotenoid) Function of, in Non-Photosynthetic Bacteria (Micheline M Mathews and W R Sistrom), 1892
  Light-induced Production of, by *Cephalosporia* (R C Codner and B C Platt), 741, *erratum*, 1108
Pigments (Chloroplast), of Deuterated Green Algae (Harold H Strain, Henry L Crespi and Joseph J Katz), 730
Pigments (Chromoprotein), of some Cryptomonad Flagellates (Photoreactive Pigments in Flagellates), (Dr Mary Belle Allen, Dr Ellsworth C Dougherty and Dr John J A McLaughlin), 1047
Pigments (Photosynthetically Active Accessory), of Cryptomonads (Photoreactive Pigments in Flagellates), (Dr F T Haxo and D C Fork), 1051
Pigments (Plant) Chromosome Breakage with (Dr Arun Kumar Sharma and Arati Gupta), 1821
Pigments (Visual), of some Common Laboratory Mammals (Dr C D B Bridges), 1727
Pigott, Dr C D Genetics and the Origin of Species, 587
Pilar de la Maza, Ma, and others Quantitative Estimation of the Fatty Acids of Olive Oil, 1941
Pillai, Dr P A Awarded a scholarship by the Lady Tata Memorial Trust, for research on Leukaemia and allied Diseases, 507
Pillai, R V (Pandalai, Dr K M, and) Albinism in Coconut Seedlings, 1163
Piltdown Skull and Jaw Radiocarbon Dating of the (Prof H de Vries and Dr K P Oakley), 224
Pinewoods of Scotland The Native (Prof H M Steven and A Carlisle), *review* by Prof E W Jones, 133
Pings, Prof C J Polynomial Representation of Thermodynamic Tables, 444
Pink Salmon Retinal Responses of, associated with its Downstream Migration (Dr M A Ali and Prof W S Hoar), 106
Pinner, Dr S H, and others Cross-linking of Cellulose Acetate by Ionizing Radiation, 1303
Pinos (Isla de) Variation in Lizards of the *Leiocephalus cubensis* Complex in Cuba and the (Albert Schwartz), 1107
Pioneer IV Radiation Measurements to 658,000 km with (Prof James A Van Allen and Louis A Frank), 219
Pioneer Research on the Atom—the Life Story of Frederick Soddy (Muriel Howorth), *review* by Prof Norman Feather, 298
Piper methysticum Forst A New Carbonyl Compound from (Prof Paul J Scheuer and Thomas J Horigan), 979
Pippard, Dr A B Awarded the Hughes Medal for 1959 of the Royal Society, 1189, 1834, work of, 1834
Pirates and Predators, the Piratical and Predatory Habits of Birds (Colonel R Meinertzhagen), *review* by Sir Landsborough Thomson, 1435
Pirie, A, and Lajtha, L G Possible Mechanism of Cysteine Protection against Radiation Cataract, 1125
Pirie, N W Forty-seven Authors in Search of a Conclusion, *review*, 920
Pirt, S J, and Callow, D S Continuous-Flow Culture of the Filamentous Mould *Penicillium chrysogenum* and the Control of its Morphology, 307
Pitcher, R S Chemical Control of Eelworms in Strawberries, 25
Piston in a Hypersonic Gun Tunnel Measurement of the Effects of Piston Mass and Bursting Pressure on the Motion of a (B J Belcher), 1207
Piston Mass and Bursting Pressure Measurement of the Effects of, on the Motion of a Piston in a Hypersonic Gun Tunnel (B J Belcher), 1207
Pitt, Dr G A J, and Morton, Prof R A Steric Aspects of the Chemistry and Biochemistry of Natural Products (*Cis-trans* Isomers of Retinene in Visual Processes), 948
Pittendrigh, Dr C S Animal Clocks (Behaviour of the Innate Circadian Rhythm of Cells and Organisms), 764
Pittendrigh, Dr C S, and others Growth Patterns in *Neurospora*—A Biological Clock in *Neurospora*, 169
Pitteway, M L V Fluctuation Phenomena and Stochastic Processes (Reflexion from an Irregular Medium), 511
Pituitary (Cowbird's) Prolactin in the, in relation to Avian Brood Parasitism (Prof E O Hohn), 2030
Pituitary Acid Phosphatases *in vitro* Effects of Methylthiouracil or Thyroidectomy on Activation of, by Whole Hypothalamic Extract (Dr V Schreiber and Dr V Kmentova), 728
Pituitary Gland (Anterior) A Dense Laminar Structure found in Conjunction with Cell Membranes in the (Barbara G Barnes), 651
Pituitary Gland (Ferret) A Nucleus of Nerve Cells in the (Dr R L Holmes), 1819
Pituitary Gland (Human) Structure of a Melanocyte-stimulating Hormone from the (Dr J Ieuan Harris), 167
Pituitary Hormones Free distribution of (Endocrinology Study Section of the United States National Institutes of Health), 1272
Pituitary-like Activity (The Anterior), of Rumen Contents (Dr F A Soliman), 1723
Pitzer, K S Thermodynamics (Phase Changes in Condensed Systems), 1609, (Irreversible Thermodynamics), 1609
Piveteau, Prof Jean At the Muséum National d'Histoire Naturelle's celebration of the anniversaries of the 'Precurseurs et Fondateurs de l'Evolutionnisme—Buffon, Lamarck, Darwin', 860
Piwkowski, Dr Tomasz R Some Semiconductive Properties of Dilute Binary Solid Solutions of Bismuth in Tellurium and Tellurium in Bismuth, 355
Place-Name Society (English) Vols 27, 28 and 29, The Place-Names of Derbyshire (Kenneth Cameron), Part 1, Introduction, River Names, etc, High Peak Hundred, Part 2, Scarsdale Hundred, Wirksworth Hundred, Morleyston and Litchurch Hundred, Part 3, Appletree Hundred, Repton and Gresley Hundred, Analyses, Index, *review* by I S Maxwell, 1767
Place-Names of Derbyshire (Kenneth Cameron), Part 1, Introduction, River-Names, etc, High Peak Hundred, Part 2, Scarsdale Hundred, Wirksworth Hundred, Morleyston and Litchurch Hundred, Part 3, Appletree Hundred, Repton and Gresley Hundred, Analyses, Index, *review* by I S Maxwell, 1767
Placenta (Human) Phospholipid Phosphoric Esters in the (G Porcellati, B Curti and S Luciani), 1870
Placer, Z, and others Passage of Insulin through the Wall of the Gastro-intestinal Tract of the Infant Rat, 1245
Plaice, Dr Constance H J (Lewis, F J W, and) Urinary β-Glucuronidase Activity in Patients with Bone Fractures, 1249
Plain Muscles (Isolated) Promoting Effect of Urea on the *in vitro* Passive Sensitization of, with Precipitating Antibody (R Binaghi, Dr B N Halpern, P Liacopoulos and T Neveu), 1805
Planck (Max-) Gesellschaft (Deutsche Bunsengesellschaft fur Physikalische Chemie and the) Colloquium on Fast Chemical Reactions in Solution, 1453
Planning More Land-Use (Prof L Dudley Stamp), 27
Planning in Pakistan (Political and Economic Planning, Broadsheet No 433), 504
Planning of Experiments (Dr D R Cox), 156
Plant (Non-Leguminous), *Hyptis suaveolens* Poit Anti-A Haemagglutinins from a (Dr G W G Bird), 109
Plant (Rice) Fixation of Nitrogen by the (S P Chakraborty and S P Sen Gupta), 2033
Plant Cell Membranes Maintenance of Semipermeability of, in the Absence of Metabolic Energy Supply (Dr B Ginzburg), 1073
Plant Diseases caused by Arabis Mosaic Virus Rôle of a Dagger Nematode (*Xiphinema* sp) in Outbreaks of (Dr B D Harrison and Dr C H Cadman), 1624
Plant Embryos A Quick Method for Extracting, from certain Types of Seed (M D Gwynne), 1588
Plant Extracts Tumour Production in Plants by (Dr Archana Sharma), 1083
Plant Geography and Ecology, International Society for International Symposium on Mapping Vegetation, B A 23
Plant Growth Activities of 5- and 8-Halogeno- Dihydro- and Tetrahydro-1-naphthoic Acids (Toshio Fujita, Sadao Imai, Koichi Koshimizu, Tetsuo Mitsui and Jiro Kato), 1415
Plant-Growth Promoting Activity Isolation of Fatty Alcohols with, from Maryland Mammoth Tobacco (Dr A J Vlitos and Dr D G Crosby), 462
Plant Growth Regulation (Boyce Thompson Institute for Plant Research, the New York Botanical Garden and the Brooklyn Botanic Garden fourth International Conference on), 599
Plant Growth Regulators in Regeneration Processes Interaction of (H Schraudolf and Prof J Reinert), 465
Plant Growth Substances (Prof L J Audus), second edition, *review* by Prof R L Wain, 925
Plant-Growth Substances and the Copper Chelation Theory of their Mode of Action (Dr C H Fawcett) 796
Plant Haemagglutinins (Lectins) A Method for Distinguishing between α- and β-Glycosides by the use of (Dr O Mäkela), 111
Plant Morphology, *review* by Dr S Williams, 84
Plant Nematodes (Dr Jesse R Christie), *review* by Dr W G Inglis, 1349
Plant Nematology (Ministry of Agriculture, Fisheries and Food, Technical Bulletin No 7), 855
Plant Nutrients Availability of (British Society of Soil Science Discussion on), 159
  Surface of the Ocean as a Source of Air-borne Nitrogenous Material and other (Dr A T Wilson), 99
Plant Origin Biological Properties of Phenols of, *review* by Dr F A Robinson, 486
Plant Pathogenic *Xanthomonas* spp Some New Specific Bacteriophages for (Z Klement), 1248
Plant Phenolics The Pharmacology of—Proceedings of a Symposium held at Oxford, 1958 (edited by J W Fairbairn), *review* by Dr F A Robinson, 486
Plant Pigments Chromosome Breakage with (Dr Arun Kumar Sharma and Arati Gupta), 1821
Plant Research, Boyce Thompson Institute for, and others Fourth International Conference on Plant Growth Regulation, 599
Plant Tissue Cultures Oxidative and Phosphorylative Activities of Cytoplasmic Particles from (Taiki Tamaoki, Prof A C Hildebrandt, A J Riker, R H Burris and Bunji Hagihara), 1491
Plant Tissues (Virus-infected) Biochemical Mechanism of Lesion Formation in (Dr F Solymosy, Dr G L Farkas and Dr Z Kiraly), 706
Plant-Virus Inhibitor from Rice Chemical Nature of a (W A Jones, M Jacobson and R P Kahn), 1146
Plantations (Even-Aged) Pathogenic Factors in the Rooting Space and the Development of (W R Day), B A 46
Plants Conversion of Salicylic Acid to Gentisic Acid and *o*-Pyrocatechuic Acid, all Labelled with Carbon-14, in (Dr Ragai K Ibrahim and Prof G H N Towers), 1803
  Distribution of Ascorbic Acid in the Leaves of some (Dr Philippe Hagene), 284
  Effects of Gibberellic Acid on Juvenility in *Marsilea* and certain other (Dr A Allsopp), 1575
  Tumour Production in, by Plant Extracts (Dr Archana Sharma), 1083
Plants on Land and in the Oceans (Dr W R G Atkins), B A 46
Plants (Cacao) Deficient in Copper Swellings on the Shoots of (Dr R G Lockard, P Vamathevan and S Thamboo), 75
Plants (Deciduous Woody), treated in Autumn with Gibberellic Acid Extended Dormancy of (Dr P W Brian, J H P Petty and P T Richmond), 69
Plants (Flowering) The Families of (Dr J Hutchinson), second edition, Vol 1, Dicotyledons, Vol 2, Monocotyledons, *review* by Prof T G Tutin, 1759
  Origin and Dispersal of (Prof A S Boughey), 1200
Plants (Higher) A New Technique for Isolating and Cloning Cells of (Ludwig Bergmann), 648
Plants (Rice) Quantitative Changes in γ-Aminobutyric Acid induced by Low Temperature in (F Zsoldos), 280
Plants (Soya Bean) Translocation of Carbon-14-labelled Amino-Acids and Amides in the Stems of young (C D Nelson and P R Gorham), 855
Plants (Strawberry) Transmission of a Virus to, by a Nematode (*Xiphinema* sp), (Asharfi Jha and Dr A F Posnette), 962, *erratum*, 1192
Plants (Vascular) Comparative Morphology of (Adriance S Foster and Ernest M Gifford, Jr), *review* by Dr S Williams, 84
Plasma of Anaemic Dogs after Nephrectomy Disappearance of the Erythropoietic Factor from (Dr Jean-Pierre Naets), 371
Plasma (Seminal), Serum and Bile Visualization of Acid and Alkaline Phosphatase after Starch-Gel Electrophoresis of (Dr Bengt Estborn), 1636
Plasma-Cell Neoplasm (Transplantable Mouse) Bence Jones Proteinuria associated with a (John L Fahey and Michael Potter), 654, *erratum*, 1108

Plasma Cholesterol in the Rat Effect of Dietary Fat and Extent of Blood Sampling on the Level of (I Coleman and J M R Beveridge), 1039
Plasma Fractions (Promethium), in Rats Distribution of (Dr Bergene Kawin), 1722
Plasma Heating by Current-Saturation (K A George), 1790
Plasma Insulin in Human Subjects Assay of, by Immunological Methods (Dr Rosalyn S Yalow and Dr Solomon A Berson), 1648
Plasma Sodium Concentration (Elevated) Effects of, on Sodium and Potassium in the Erythrocyte of the Lizard *Trachysaurus rugosus* (Gray), (P J Bentley), 1403
Plasmalogen Reaction of Mercuric Chloride with (Dr William T Norton), 1144
Plaster (Gypsum) Effect of Temperature on the Rate of Setting of (M J Ridge), 47
Plasticity of Erythrocytes coated with Incomplete Antibodies Loss of (Prof C T Nicolau, P Teitel and M Fotino), 1808
Plastics Lectures on (City of London College, in collaboration with the Plastics Institute), 508
Plastics (Ageing of) International Symposium on the (Eighth German Plastics Convention), 508
Plastics Convention Eighth German (International Symposium on the Ageing of Plastics), 508
Plastics Institute Annual Lecture (Lord Verulam), 1688
Plastics Institute (City of London College, in collaboration with the) Lectures on Plastics, 508
Plastron Respiration in the Eggs of *Drosophila* and other Flies (Dr H E Hinton), 280
Platelets (Long), from Pulmonary Megakaryocytes A Possible Explanation of the Formation of (Dr J George Sharnoff), B A 75
Plates (Crystal), between Crossed Polars A Special Case of the Superposition of, and its Bearing on the Microscopy of Cellulosic Fibres (Dr N H Hartshorne), 179
Platinum (II) Structure of α-Hydroxyacetylene Complexes of (Dr J Chatt, L A Duncanson and R G Guy) 526
Platinum in Mercury Influence of, on the Mechanism of Electrode Reactions at the Mercury Electrode (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus), 1795
Platon a Copernic Le Systeme du Monde—Histoire des Doctrines Cosmologiques de (Prof Pierre Duhem), Tome 10, *review* by Prof E J Dijksterhuis, 836
Platt, B C (Codner, R C, and) Light-induced Production of Carotenoid Pigments by *Cephalosporia*, 741, *erratum*, 1108
Platt, Sir Harry Biomechanics, 513
Platt, H Renewal Times of some Squamous Epithelia in the Guinea Pig, 1654
Pleistocene Climatic Significance of Calcretes and Ferricretes (Dr R J Mason, A B A Brink and K Knight), 568
Plenderleith, Dr H J Appointed first director of the International Centre for the Study of the Preservation and Restoration of Cultural Property, 504
Plesiosaur A Giant, 1914
Plots (Non-Inverted versus Inverted) in Enzyme Kinetics (Dr B H J Hofstee), 1296, (Dr Malcolm Dixon and Dr Edwin C Webb), 1298
Plunkett, R (edited by) Colloquium on Mechanical Impedance Methods for Mechanical Vibrations, presented at the Annual Meeting of the American Society of Mechanical Engineers, 1958 *review* by Prof R E D Bishop, 1764
Pneumococci Transformation Reaction of, in the Absence of Serum Factor (Prof Takeshi Odaka and Tadashi Watanabe), 471
Poa pratensis L A 'Progressive' Mutation induced in, by Ionizing Radiation (A A Hanson and F V Juska), 1000
Pochet, P, et autres Recherches sur l'Autosterilite du Cafeier robusta (*Coffea canephora* Pierre), 518
Pocock, N J B Awarded a Mond Nickel Fellowship for 1959, 1272
Podzol Soil Oxygen-containing Functional Groups in the Organic Matter of a (J R Wright and J Schnitzer), 1462
Poe, A J, and Vaidya, M S A Radiochemical Tracer Study of the Relative Stability of the Halogenoplatinates, 1139
Point Defects in Metals and Alloys Vacancies and other—a Symposium organized by the Institute of Metals, 1957 (Monograph and Report Series, No 23), *review* by Dr F C Thompson, 1765
Poisoning by Carbon Tetrachloride Prophylaxis o (C H Gallagher and R A Simmonds), 1407
Poisoning (Organophosphorus) in the House-Fly Esterase Inhibition and (Dr D Stegwee), 1253
Polanyi, Prof M Knowing and Being, 1194
Polar Diagrams of Birds Radar Echoing Area (J Edwards and E W Houghton), 1059
Polar Dyes Incorporation of N-Methyl Carbon of Monoethylaminoazobenzene into (Prof Hiroshi Terayama, Prof Morizo Ishidate and Akira Hanaki), 1460
Polar Front Survey in the North Atlantic Ocean, 1180
Polar Ice Caps Temperatures in (Dr Uwe Radok), 1056
Polarisationsmikroscop Die gesunden und die erkrankten Zahngewebe des Menschen und der Wirbeltiere im (Prof W J Schmidt und Dr A Keil), *review* by Prof A I Darling, 218
Polarity of Benzene and Borazole Substituents Intermolecular Distances and Diamagnetic Anisotropy in Crystals as Measures of the (Dame Kathleen Lonsdale), 1060
Polarity (Reversed) Resting and Action Potentials of, in Frog Nerve Cells (Dr I Tasaki), 1574
Polarization Deviation of Zone Lenses produced by (Prof Jurgen R Meyer-Arendt), 811
Polarization of Light from Noctilucent Clouds (Georg Witt), 1618
Polarization and Resolving Time Effects in Photon Correlation (Dr E Brannen and Prof W Wehlau), 263
Polarized Light Orientation of Animals to (Dr H Kalmus), 228
  Response of a Single Retinula Cell to (M Kuwabara and K Naka), 455
Polarographic Determination of Serine A Micromethod for the (J Ladik and Dr I Szekacs), 188
Polarographic Maximum of Copper Effect of Polycyclic Aromatic Hydrocarbons on the (C E Searle), 1716
Polarographic Society First Medal awarded to Prof J Heyrovsky, 772
Polars (Crossed) A Special Case of the Superposition of Crystal Plates between, and its Bearing on the Microscopy of Cellulosic Fibres (Dr N H Hartshorne) 179
Policy (Land Use), in Tropical Catchment Areas A Physical Basis for (Dr H C Pereira), 1768
Polio Virus Ribonucleic Acid Infectivity of, for Embryonated Eggs and Unsusceptible Cell Lines (F De Somer, Dr A Prinzie and E Schonne), 652
Poliomyelitis Virus Appearance of Crystalline Needles in Monkey Kidney Cell Cultures infected with, and Incubated at 22-30° C (Dr Esther Tenenbaum), 1657
Polish Academy of Sciences Election of Sir John Russell as a member, 95
Polished Metal Surfaces The Nature of (L E Samuels), 1280
Political and Commercial Control Two Threats to Broadcasting— (H Carleton Greene), 661
Political and Economic Planning Broadsheet No 431, Prospects for Nuclear Power, 383
  Broadsheet No 433, Planning in Pakistan, 504
  Broadsheet No 434, Management and Under-developed Territories, 483
  Broadsheet No 435, The Work of Newspaper Trusts, 1687
Political and Social Science, American Academy of Annals, May, 1959, Partnership for Progress—International Technical Co-operation, *review* by R Brightman, 1673
Pollard, Dr F H Gas Chromatography, 1199
Pollard, H Marvin, and others Some Enzymatic Properties of Suspensions of Parenchymatous Liver Cells, 1400
Pollard, Morris (edited by) Perspectives in Virology—a Symposium, *review* by N W Pirie, 920
Pollen of *Acacia* from Tufaceous Limestone near Udaipur (T Trivedi), 123
Pollen (Fossil), from Seymour Island, Antarctica (Lucy M Cranwell), 1782
Pollen Tubes Effect of Gibberellin on the Growth of (Nanda Bose), 1577
Pollination (Interspecific) Production of Seedless Hops by (Prof Edward L Davis), 1336
Pollution River (Dr Louis Klein), I, Chemical Analysis, *review* by Prof R Belcher, 1177
Pollution (Oil), of the Sea, Co-ordinating Advisory Committe on International Conference, 940
Pollution (River) Sewage Disposal and Trade Waste Treatment (Department of Civil Engineering and the Department of Extra-Mural Studies in the University of Birmingham Course on), 1451
Polunin, Dr Nicholas Circumpolar Arctic Flora, *review* by R D Meikle, 1347
Polyaldehyde Moieties in Sections and Smears Fluorescent Schiff-Type Reagents for Cytochemical Detection of (Prof Frederick H Kasten, Vivian Burton and Peggy Glover), 1797
Polycyclic Aromatic Hydrocarbons Effect of, on the Polarographic Maximum of Copper (C E Searle), 1716
Polyethylene Absorption Cells for Infra-Red Spectrophotometry (Trevor Robinson), 448
Polygalacturonase in Lucerne and Clover Effect of *Rhizobium* Polysaccharide on the Formation of (H Ljunggren and G Fahraeus), 1578
Polyglucoses (Synthetic) Reduction of Toxicity of Cationic Macromolecules by Complexing with Anionic Derivatives of (P T Mora, B G Young and M J Shear) 431
Polyisoprene Incorporation of DL-[2-^{14}C] Mevalonic Acid Lactone into (R G O Kekwick, B L Archer, D Barnard, G M C Higgins, G P McSweeney and C G Moore), 268, *erratum*, 772
Polymer, a Journal to Promote the Science of Large Molecules (Butterworths Scientific Publications, Ltd), B A 16
Polymer Chemistry Recent Progress in (Prof H Mark), 156
Polymer (High) Chemistry New Techniques in (Bradford Institute of Technology Course in) 1845
Polymer Phase Systems (Aqueous) Counter-Current Distribution of Proteins in (Per-Ake Ålbertsson and Ed Jacques Nyns), 1465, *erratum*, 1688
Polymer Science (Applied), Journal of, Vol I, No I, 784
Polymer Single Crystals Evidence for Distinct Sectors in (D C Bassett, Prof F C Frank and Dr A Keller), 810
Polymerization of Phosphonitrilic Chlorides (Prof Thomas R Merton), 899
Polymerizations (Vinyl), initiated by γ-Rays A Capacitance Method for following (G J K Acres and F L Dalton), 335
Polymerized (Highly) Spleen Deoxyribonucleic Acid labelled with Phosphorus-32 Injected Intraperitoneally into Rats Fate of the (Tamara A Hudnik-Plevnik, Vladimir R Glišin and Marta M Simić), 1818
Polymethacrylic Acid Electron Paramagnetic Resonance at 4 2°K of λ-Irradiated Polymethyl Methacrylate and (Dr Derick W Ovenall), 181
Polymethyl Methcrylate (λ-Irradiated), and Polymethacrylic Acid Electron Paramagnetic Resonance at 4 2°K of (Dr Derick W Ovenall), 181
Polymorphic Population Recombinational Lethals in a (J B Gibson and Prof J M Thoday), 1593
Polymyxin and Acetone Combined Use of, to obtain Cell-free Enzymes (J R Villanueva), 1565
Polynomial Representation of Thermodynamic Tables (Prof C J Pings), 444
Polynuclear Complexes of Molybdenum (II), (Dr J C Sheldon), 1210
Polynucleotide Phosphorylase in Atypical Epithelioma of Rat Occurrence of (Dr Kunio Yagi, Takayuki Ozawa and Hiroshi Konogi), 1939
Polyols Formation of, by the Lens of the Rat with 'Sugar' Cataract (Dr Ruth van Heyningen), 194
Polyoma Formation of Different Cell–Virus Relationships in Tumour Cells induced by (Dr Leo Sachs and Ernest Winocour), 1702
Polyoma-induced Tumours Influence of Adult Lymphoid Tissues on (Dr V Defendi and Dr H Koprowski), 1579
Polyoma Virus (Parotid Tumour Virus) Antibody Status of Mice and Response of their Litters to (Lloyd W Law, Clyde J Dawe, Wallace P Rowe and Janet W Hartley), 1420
Polypeptides (Synthetic) Immunochemical Studies of Polypeptidyl Proteins and (Prof M A Stahmann, D J Buchanan-Davidson, Dr C Lapresel and Dr P Grabar), 549
Polypeptidyl Proteins and Synthetic Polypeptides Immunochemical Studies of (Prof M A Stahmann, D J Buchanan-Davidson, Dr C Lapresel and Dr P Grabar), 549
Polyphenoloxidase (Insect) Interaction between Thiourea and (Wanda Chmurzynska and Lech Wojtczak), 1941
Polyphenoloxidase Substrate of the Banana Detection and Identification of the (Dr L A Griffiths), 58

Polyphloretin Phosphate Effect of, on the Suspension Stability of Red Blood Corpuscles (Dr Bengt Fries), 62

Polyploidy (Intraspecific), and Evolution of Diverse Morphological Forms in *Convolvulus pluricaulis* Chois (Dr S L Tandon and C P Mzalik) 481

Polypodiaceous Ferns Deoxyribonucleic Acid in Eggs of the (Dr P R, Bell), 1664

Polyporic Acid Antileukaemic Activity of (J F Burton and B F Cain), 1326

Polysaccharide (Extracellular), of *Azotobacter vinelandii* A Function for the (Dr Michael H Proctor), 1934

Polysaccharide (*Rhizobium*) Effect of, in the Formation of Polygalacturonase in Lucerne and Clover (H Ljunggren and G Fahraeus), 1578

Polysaccharide Chemistry Application of the Mass Spectrometer to (Dr P A Finan and Dr R I Reed), 1866

Polysaccharides (Group and Type-specific), of Group *D* Streptococci (Dr S D Elliott), 1342

Polysaccharides (Fibrillar) Liquid Crystal Systems from (R H Marshessault, F F Morehead and N M Walter), 632

Polytechnic Management Association New Development Series No 3, New Developments in Training—Five Studies in the Efficient Communication of Skills (edited by Frank A Heller), 421

Polyvinyl Chloride and Polyvinyl Acetate Separation of, by Chromatographic Methods (W J Langford and D J Vaughan), 116

Polyvinyl Acetate Gas Chromatographic Separation of Long-chain Fatty Acid Methyl Esters on (Irwin Hornstein, L E Elliott and P F Crowe), 1710

  Separation of Polyvinyl Chloride and, by Chromatographic Methods (W J Langford and D J Vaughan), 116

Ponder, Dr Eric, and Ponder, Ruth V Partial Identification of Lysins and Agglutinins in Lymphomatous Mouse Tissue, 819

Ponder, Ruth V (Ponder, Dr Eric, and) Partial Identification of Lysins and Agglutinins in Lymphomatous Mouse Tissue, 819

Pontecorvo, Prof G Trends in Genetic Analysis, *review* by J Maynard Smith, 752

  Biological Sciences, *review*, 1902

Ponten, Dr J Awarded a grant by the Lady Tata Memorial Trust, for research on Leukaemia and allied Diseases, 507

Poole, J B, and others A New Approach to the Dating of the Dead Sea Scrolls, 533

Pooled Human Gamma-Globulin Staphylocoagulase Inhibition by (Prof Murray M Streitfeld, Prof Bennett Sallman and Seymour M Shoelson), 1665

Poore, Prof M E D Appointed to the chair of botany in the University of Malaya in Kuala Lumpur, 306 , work of, 306

Pope, Dr J A Metal Fatigue, *review* by Dr K M Entwistle, 1438

Pope, M I (Gregg, S J, and) Coal Science (Ultra-fine Structure of Coals and Chars—Effect of Pressure and of Exposure to Atmospheres of various humidities on the Electrical Conductivity of Coal Artefacts), 413

Popov, —, and others Ionization Phenomena in Gases (The Interaction of a Beam of Charged Particles with a Plasma), 1356

Popper, P Special Ceramics (Preparing an Extremely Strong, Dense Silicon Carbide, without the Need for Hot-pressing), 1116 , (Silicon Nitride—its Preparation, its Properties as an Engineering Material and its Microstructure), 1116

Popper, P (Ingles, Dr T A, and) Special Ceramics (Preparation of Boron Nitride), 1116

Population The Study of (edited by Philip M Hauser and Otis Dudley Duncan), *review* by Dr B Benjamin, 1521

Population (*Baptisia* Hybrid) Applications of Paper Chromatography to Systematics—Recombination of Parental Biochemical Components in a (Dr R E Alston and Dr B L Turner), 285

Population (Lead-tolerant), of *Agrostis tenuis* Adaptation of a, to Low Soil Fertility (D Jowett), 43

Population (Mast Cell), of Lung of the Guinea Pig and other Tissues (Dr W G Smith), 1154

Population (Microbial) Effect of the Level of, on Isotopically Exchangeable Phosphate in Soil (Dr P Newbould and Dr R L Lucas), 1155

Population (Normal American) An Association between Abo Blood Groups and Fertility in a (Dr T Edward Reed and Dr J H Ahronheim), 611

Population (Polymorphic) Recombinational Lethals in a (J B Gibson and Prof J M Thoday), 1593

Population Council, Inc, New York Grant of 89,348 dollars to the National Institute for Research in Dairying, in support of researches on cervical mucus, with particular reference to the control of fertility, 1362

Population Ecology A Controversial Equation in (Dr A Milne), 1582 , (W B Yapp), 1582 , (Prof G C Varley), 1583

Population Subdivision Genetical Effects of (P A P Moran), 505

Populations Estimating Earthworm, by using Formalin (Dr F Raw), 1661

Populations (Animal) Exploitation of Natural (British Ecological Society Symposium on), 1451

Populations (Nematode) Effective Increase in, by the Addition of Aureomycin (C O R Everard and William A Feder), 1887

Porath, Dr J, and others Gel Filtration as a Method for Purification of Protein-bound Peptides as exemplified by Oxytocin and Vasopressin, 1565

Porcellati, G, and others Phospholipid Phosphoric Esters in the Human Placenta, 1870

Pork and Fish (Freeze-dried) Absorption of Atmospheric Moisture by (Norman A Matheson), 1949

Porous Materials The Structure and Properties of—Proceedings of the Tenth Symposium of the Colston Research Society held in the University of Bristol, 1958 (edited by D H Everett and F S Stone), *review*, 1525

Porous Media Sedimentation Rates, Fluidization and Flow through (Colin C Harris), 716

Porphyrin Biosynthesis (Haem and) Effect of Oxygen Tension on (J E Falk, R J Porra, Ann Brown, F Moss and Helen E Larminie), 1217

Porphyrin Ring Formation of the (Prof Jonathan B Wittenberg), 876

Porphyrins (Formyl) Reaction of, with Acetone-Hydrochloric Acid (Dr P S Clezy), 1142

Porra, R J, and others Effect of Oxygen Tension on Haem and Porphyrin Biosynthesis, 1217

Portela, A, and others Effects of Irradiation of Nerve on Muscular Response, 734

Porteous, Prof Norman W Myth and Ritual, *review*, 1972

Porter, Prof G, and Smith, Dr J A Mechanism of Atom Recombination, 446

Porter, Prof G, and Weber, Dr G Energy Transfer with special reference to Biological Systems, 688

Porter, Prof G, and Wilkinson, F Fast Chemical Reactions in Solution, 1453

Porter, Prof G, and Wright, Dr M R Energy Transfer with special reference to Biological Systems (Processes of Deactivation involving Change of Multiplicity), 689

Porter, Dr Roger S, and Johnson, Dr Julian F Volatile Liquid Partition Chromatography, 978

Porter–Silber and Schiff Reagents Use of, as Spot Tests for Steroids applied on Paper and their Application to the Study of Rat Adrenal Lipids (Dr Marion K Birmingham), B A 67

Portland Cement (Hydrated) Carbonate Minerals in (W F Cole and B Kroone), B A 57

Posener, Dr D W At the Second Australian Spectroscopy Conference (Microwave Spectroscopy), 1197

Position (Taxonomic), of *Arthrobacter* (Dr C S Cummins and Dr H Harris), 831

Positions of Microscopical Objects Recording the (Dr J R Baker), 34

Positions (Astronomical), of Uranus Great Earthquakes and the (Prof A Tomaschek), 177

Positive Inotropic Activity of Cytidine Triphosphate (Winifred G Nayler and Marian McCulloch), 67

Posnette, Dr A F (Jha, Asharfi, and) Transmission of a Virus to Strawberry Plants by a Nematode (*Xiphinema* sp), 962, *erratum*, 1192

Pospisil, Dr M, and Novak, Dr L Importance of the Type of Metabolism for the Radiosensitivity of Mice, 1814

Possible Asymmetry in the Daily Range of the Geomagnetic Vertical Intensity around the Magnetic Equator (Dr C A Onwumechilli), 51

Possible Explanation of the Formation of Long Platelets from Pulmonary Megakaryocytes (Dr J George Sharnoff), B A 75

Possible Explanation for Part of the Difference in Heat Tolerance Exhibited by *Bos taurus* and *Bos indicus* Beef Cattle (H P Ledger), 1405

Possible Intermediate Metabolite of Benzene Hexachloride in Houseflies Pentachloro*cyclo*hexene as a (R G Bridges), 1337

Possible Mechanism of Cysteine Protection against Radiation Cataract (A Pirie and L G Lajtha), 1125

Possible Relation between Carcinogenicity and Ease of Hydrolysis *in vitro* of Derivatives of 2-Aminofluorene (Prof Mary F Argus and Francis E Ray), 2018

Possible Relation with an Excess of Iron in the Forage A Lesion of the Follicle and of the Fibre of Wool and its (Prof G Gonzelez, J Garcia and E. Fernandez), 559

Possible Reversals of the Earth's Magnetic Field in the Jurassic Period (Dr R W Girdler), 540

Possible Rôle of Glycerol in the Winter-Hardiness of Insects (P Dubach, D Pratt, Prof F Smith and C M Stewart), 288

Possible Rôle of Higher Proprioceptive Centres in the Perception of Visual Space and in the Control of Motor Behaviour (Dr B Gurevitch), 1219

Possible Rôle of Indoleacetic Acid Oxidase in Crown Gall Tumour Induction (Dr Jacques Lipetz), 1076

Possible Simplified Structure of Deoxyribonucleic Acid (Dr M H Silk and A O Hawtrey), 1484

Post, R F Ionization Phenomena in Gases (Recent Progress in Mirror Machines), 1356

Post Office, General Appointment of A H Mumford as engineer-in-chief, 1531

  Retirement of Sir Lionel Harris as engineer-in-chief, 1531

  Appointment of Capt C F Booth and D A Barron as deputy engineers-in-chief, 1531

Post-Activation Changes at the Mammalian Neuromuscular Junction (J I Hubbard), 1945

Postdoctoral Fellowships (United States National Science Foundation), 1534

Post-Exposure Analysis of Organic Compounds in the Blood by a Rapid Infra-red Technique (Dr R D Stewart, D S Erley, T R Torkelson and C L Hake), 192

Postganglionic Mechanism Sympathetic (Prof J H Burn and M J Rand), 163

Postgraduate Agricultural Research Scholarships Junior (Agricultural Institute of Ireland Awards), 1612

Postgraduate Courses, 1959-60 (Imperial College of Science and Technology), 235

Postgraduate Research Studentship founded by the Phillips Petroleum Co at University College of North Staffordshire, 322

Postgraduate Research Studentship (a second) founded by the United States Rubber Co at University College of North Staffordshire, 322

Postgraduate Training in the Public Health Aspects of Nuclear Energy (World Health Organization, Technical Report Series No 154), 33

Potash Institute, International Sixteen Papers read at the Fourth Congress of the (Vienna, 1957), *review*, 1976

Potash Salts Biological Action of Potassium-40 in Naturally Occurring (Prof E Welte and KI Mechsner), 1958

Potassium Glass Micro-Electrodes for Measuring Intracellular Activities of Sodium and (Dr J A M Hinke), 1257

Potassium-40 Biological Action of, in Naturally Occurring Potash Salts (Prof E Welte and KI Mechsner), 1958

Potassium-42 Relative Rates of Exchange of, by the Foetal Metanephros and Foetal Liver (Dr J G Bearn and Dr F T C Harris), 1959

Potassium, Calcium and Magnesium Effect on the Groundnut of Variations in Supply of (Dr R Comber), 1003

Potassium and Lactose in Milk in relation to the Physiology of Milk Secretion (Dr J A F Rook and Marian Wood), 647

Potassium/Sodium Ratio in Rainwater (B C V Oddie), 1791

Potassium (Sodium and), in the Erythrocyte of the Lizard *Trachysaurus rugosus* (Gray) Effects of Elevated Plasma Sodium Concentration on (P J Bentley) 1403

Potassium Fluxes (Salicylate and), of Rat Diaphragm (Dr J A Hicklin), 2029

Potassium Salt of Gibberellic Acid Effect of the, on the Growth and Reproduction Rate of *Paramecium multimicro-nucleatum* (A A Oravec, N G Strovilas, J L Beal and Arthur Tye) 1405
Potassium Symposium 1957—Sixteen Papers read at the Fourth Congress of the International Potash Institute, *review*, 1976
Potassium rich Solutions Action Potentials from Single Nodes of Ranvier in (Dr Hans-Christoph Luttgau), 1494
Potato (Sweet) Effect of Indole Acetic Acid and α-Naphthalene Acetic Acid on the Growth, Flowering and Fruit Set in (G Satyanarayana and Dr G Rangaswami), B A 73
Potato Beetle (Colorado), *Leptinotarsa decemlineata* (Say) Common Attractant for the Tobacco Hornworm, *Protoparce sexta* (Johan) and the (Dr Robert T Yamamoto and Prof G Fraenkel), 206
Potato Starch Granules Physical and Chromatographical Observations of γ-Irradiated (Akira Mishina and Ziro Nikuni), 1867
Potent New Analgesic Identification of Phenazocine, a (Dr E G C Clarke), 451
Potentials (Action), from Single Nodes of Ranvier in Potassium-rich Solutions (Dr Hans-Christoph Luttgau), 1494
Potentials (Evoked), in Visual Cortex of the Unanaesthetized Cat (Gabriel Horn and John Blundell), 173
Potentials (Nerve Action) Amplitude-Modulation Radio-Telemetry of (Roger M Morrell), 1129
Potentials (Redox), in Soybean Nodules during the Vegetative Period (Dr Helena Ebertova), 1046
Potentials (Resting and Action), of Reversed Polarity in Frog Nerve Cells (Dr I Tasaki), 1574
Potentiation of Contractions after Rest in the Isolated Rat Ventricle Preparation (Dr R L Speirs), 66
Potter, Dr H H *Obituary*, 1912
Potter, Michael (Fahey, John L , and) Bence Jones Proteinuria associated with a Transplantable Mouse Plasma-Cell Neoplasm, 654, *erratum*, 1108
Potteries Industrial Health in the, 420
Potts, W H Biological Problems arising from the Control of Pests and Diseases, 1101
Poulik, Dr M D Separation of Prealbumins by Starch Gel Electrophoresis, 1067
Poulik, Dr M D , and others Separation of Fast-Moving γ-Globulins by Starch-Gel Electrophoresis, 1800
Poulton, E C Effects of Printing Types and Formats on the Comprehension of Scientific Journals, 1824
Poults (Turkey) Effect of Thioctic Acid on Gain in Body-Weight by (J R Jowsey, R M Blakeley and H I MacGregor), 1323
Powder Rapid Estimation of the Specific Surface of a (Dr H E Rose and R M E Sullivan), 46
Powder Method in X-Ray Crystallography (Prof Leonid V Azaroff and Prof Martin J Buerger), *review* by Prof H Lipson, 1599
Powder Methods X-Ray, *review* by Prof H Lipson, 1599
Powdered Tragacanth (Tragacanthae Pulvis, B P) Growth Inhibition of Mouse Ascites Tumour Cells by (Dr E M F Roe), 1891
Powell, C , and Hendley, D A Awarded the Clerk Maxwell Premium of the British Institution of Radio Engineers, 857
Powell, the late Joan F , and Strange, R E Synthesis of Dipicolinic Acid from αε-Diketopimelic Acid, 878
Power, E A (Griffiths, Dr T C , and) Nuclear Forces and the Few-Nucleon Problem, 1113
Power, Ministry of Thirty-sixth Annual Report (1957) of the Safety in Mines Research Establishment, 154
  Appointment of Dr C M Cawley as chief scientist, 232
  Appointment of Major-General S W Joslin as chief inspector of nuclear installations, 680
Power (Separating), of Packed and Capillary Gas Chromatographic Columns Comparison of Efficiency and (Dr J H Purnell), 2009
Power Generation Nuclear Reactors for (edited by E Openshaw Taylor), *review* by R Vaux 301
Power Projects The St Lawrence Seaway and—Geographical Background (Prof T L Hills) B A 49
Power Reactors (Directory of Nuclear Reactors, Vol I), (International Atomic Energy Agency), *review* by Dr A J Salmon, 1438
Power (Nuclear) Development of, *review* by R Brightman 1673
  The Economics of, including Administration and Law (edited by I R Maxwell, P W Mummery and Philip Sporn), Vol 2, *review* by R Brightman, 1673
  Prospects for (Political and Economic Planning, Broadsheet No 431), 383
  Research and Development Charges in Civic, 406
Power (Nuclear), and its Development, 383
Power (Nuclear) Station The Japanese, 407
Powles, Dr J G Molecular and Atomic Motions by Radio-Frequency Methods—Maxwell-A M P E R E Conference, 157
Powles, Dr J G , and Cutler, D Proton Resonance Relaxation Times in Mobile Liquids, 1123
Powning, R F , and Irzykiewicz, H A Reduced Triphosphopyridine Nucleotide-linked Cystine Reductase in the Clothes Moth, *Tineola bisselliella* (Humm), 1230
Poynter, Dr F N L Distribution of Scientific Publications in Underdeveloped Countries, B A 23
Practical Animal Ecology (W H Dowdeswell), *review* by Prof J B Cragg, 1262
Practical Use of the Microscope (George Herbert Needham), *review* by Dr S Bradbury, 1174
Practice Electrophoresis in Theory and, *review* by Dr R Consden, 84
Practice of Crop Protection The Principles and, *review* by F C Bawden, 1258
Practice of Semiconductors An Introduction to the Theory and (Dr A A Shepherd), *review* by Dr R A Hyman, 1754
Pragmatics (Systematic) Toward a (R M Martin), *review* by F I G Rawlins, 754
Prain, Sir Ronald Elected president of the Institute of Metals, 1688
Prantl, Dr F Elected to foreign membership of the Geological Society of London, 1360
Prasad, A N , and Craggs, J D Ionization Phenomena in Gases (Recent Measurements on the Growth of Pre-breakdown Ionization Currents for Air), 1354
Pratt, D , and others Possible Role of Glycerol in the Winter-Hardiness of Insects, 288
Pratt, Dr D D Retirement from the directorship of the National Chemical Laboratory, 1610 , work of, 1610
Pratt, M W T , and Helsby, R Ultrasonically Dispersed Sodium, 1694
Prealbumins Separation of, by Starch Gel Electrophoresis (Dr M D Poulik), 1067
Pre-Cambrian Geology of South-western Australia (A F Wilson) 237
Pre-Cambrian Gneiss of Ongul Islands in the Antarctic Natural Remanent Magnetization of (T Nagata and Y Shimizu), 1472
Pre-Cambrian Ice Age (Late) Palaeomagnetism in some Norwegian Sparagmites and the (W B Harland and D E T Bidgood), 1860
Precipitate (A New Nitride), in Iron-Silicon Alloys (G R Booker and J Norbury), 1311
Precipitated Cadmium Sulphide Structure of, as studied by Single-Crystal Electron Diffraction Pattern (Dr Ryoitiro Sato), 2005
Precipitating Antibody Promoting Effect of Urea on the *in vitro* Passive Sensitization of Isolated Plain Muscles with (R Binaghi, Dr B N Halpern, P Liacopoulos and T Neveu), 1805
Precipitation Reaction (Surface) A Method for the Quantitative Study of the (Francis T Ashton), 1735
Precipitator (Long-Running Thermal) Measurement of Asbestos Dust Concentrations with the (Dr C G Addingley and Dr R Gaze), 715
Precipitins (Human), against Common Pathogenic and Non-Pathogenic Fungi (Dr J Pepys, Dr R W Riddell and Dr Y M Clayton), 1328
Precursor for Haemoglobin Nonhaem Iron in Erythrocytes as a (Dr M Faber and Dr I Falbe-Hansen) 1043
Precursors (Nicotinamide Analogues and) Reversal of Effects of 2-Substituted Thiadiazoles by (Dr Irwin H Krakoff, Corrine R Lacon and Dr David A Karnofsky), 1805
Predators Pirates and—the Piratical and Predatory Habits of Birds (Colonel R Meinertzhagen), *review* by Sir Landsborough Thomson, 1435
Prediapause Eggs of *Aedes* Mosquitoes Control of Hatching in the (Dr J D Gillett), 1621
Prediction of Selection Factors in a Tropical Trawl Fishery (Alan R Longhurst), 1170
Prediction of Sunspot Numbers until the End of the Present Cycle (Dr P Herrinck), 51
Prediction of Sunspot Numbers for Cycle 20 (Dr W B Chadwick), 1787
Prediction (Electronic), of Swarming in Bees (E F Woods), 842
Preece, Prof A *Obituary* by Prof A F Burstall, 316
Preece, B W Appointed assistant lecturer in engineering at the University College of Swansea, 156
Preece E R , and others Atomic Weight of Silver, 358
Preer, Dr John R The Structure of Science (Mechanism of Gene-action), B A 8
Prefreezing as a Method enabling Animals to survive Freezing at an Extremely Low Temperature (Eizo Asahina), 1003
Prégermain, S (Chiche, P , and) Coal Science (Ultra-fine Structure of Coals and Chars), 413
Pregnancy Blood Cortisol in the Sheep—Normal Concentration and Changes in Ketosis of (H R Lindner), 1645
Pregnancy in the Mouse An Exteroceptive Block to (Hilda M Bruce), 105
Pregnancy in Ovariectomized Ewes Maintenance of by means of Progesterone (N W Moore and L E A Rowson), 1410
Prehistoric Background of Indian Culture (Colonel D H Gordon), *review* by M C Burkitt, 131
Prehistoric Wooden Trackways Radiocarbon Dating of (Dr H Godwin and Dr E H Willis), 490
Prehistory Indian, *review* by M C Burkitt, 131
Prehistory (Australian) Dating of (D J Mulvaney), 918
Preliminary Observations on the Fate of Intravenously Administered Lactose Labelled with Carbon-14 (Dr Frederick J Carleton and Dr Henry R Roberts), 1650
Prelude to Space Research, *review* by D G King-Hele, 663
Premiums for articles on Electronics (Radio Industry Council and the Electronic Engineering Association), 943
Prenatal Development Environmental Influences on (edited by Beatrice Mintz), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Prentice, Neville, and others Production of Emetic Material by Species of *Fusarium*, 1319
Preobragenski, Prof J V Polar Front Survey (Hydrography—Greenland and Norwegian Seas) 1181
Preobragenski, Prof J V (Betin, Dr V V , and) Polar Front Survey (Hydrography—Ice Research in the Baltic) 1183
Preparation of Crystalline *trans-trans* Methyl Linoleate Hydroperoxide (A Banks, S Fazakerley, J N Keay and J G M Smith), 816
Preparation of Diamond (Dr H P Bovenkerk, Dr F P Bundy, Dr H T Hall, Dr H M Strong and Dr R H Wentorf, jun), 1094
Preparation of a Highly Purified Carbohydrate-free Johnin Protein (E Annau), 1642
Preparation of a Highly Purified Sample of the Urinary Gonadotrophin (Roland Bourrillon René Got and René Marcy), 983
Preparation (Coal) Second Symposium on (Department of Mining, University of Leeds, 1957), *review* by Prof S G Ward, 1601
Prescott, Prof J C Retirement from the chair of electrical engineering in King's College, Newcastle-upon-Tyne, 404 , work of, 404
Presence of Activated Charcoal Carbonization of Coals in the (Studies of Coal), (R L Bond, A M Godridge, A R Murnaghan, D H Napier and D J Williams), 425
Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates Pharmacological Evidence for the (Active Principles of the Neurohypophysis of Cold-blooded Vertebrates), (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464
Presence of Behinic Acid in Sphingomyelin from Horse Spinal Cord (Prof Yasuhiko Fujino and Takashi Negishi), 817
Presence of certain Onium Compounds in Brain Tissue following Intravenous Administration to Rats (Prof Ruth R Levine), 1412
Presence of Oxygen in Irradiated Solutions Aromatic Ring Opening in the (Israel Loeff and Gabriel Stein), 901

Presence in Rose Hips of Substances Inhibiting the Oxidation of Ascorbic Acid (Dr G A D Jackson and R B Wood), 902
Present Systems of Superannuation Difficulties in the, 503
Presentation of Bone Sarcoma in Man A Seasonal Rhythm in the (Dr C H G Price), B A 76
Preservation of Antiquities Chemistry in the (British Association for the Advancement of Science, Sections B (Chemistry) and H (Anthropology), Discussion on), 585
Preservation of Cornish Scenery, 1776
Preservation of the Malvern Hills, 1272
Preservation of Natural and Historical Monuments and Relics, Southern Rhodesia, (Commission for the) Khami Ruins—Report on Excavations, 1947-1955 (K R Robinson), *review* by R R Inskeep, 1349
Preservation of Rural England, Council for the (Sheffield and Peak District Branch) Twenty-eighth Annual Report (1959), 408
Preservation and Restoration of Cultural Property, International Centre for the Study of the Inauguration of the, 504
  Appointment of Dr H J Plenderleith as first director, 504
Preservatives (Water-borne) Limitations Imposed by some, on the Soil Block Test Method for Timber (A J MacQuire), 1430
President of the United States, Science Advisory Committee to the Report on Education for the Age of Science, 81, 87
Pressey, B G Signals from Satellite 1958 δ2 (*Sputnik III*), 261
Pressor Activity (Oxytocic and) Peptides with, obtained from Acidified Rat Serum (Prof H Croxatto T Pereda and R Mellada), 1496
Pressure World Distribution of Atmospheric Water Vapour (G A Tunnell), B A 15
Pressure (Bursting) Measurement of the Effects of Piston Mass and, on the Motion of a Piston in a Hypersonic Gun Tunnel (B J Belcher), 1207
Pressure (High-) Oxygen and Radiotherapy, 94
Pressure (Reduced) Habit of Ice Crystals grown in Hydrogen, Carbon Dioxide and Air at (A P van den Heuvel and Dr B J Mason), 519
Pressure (Rock), in Mines (E de St Q Isaacson), *review* by J K L Graham, 1349
Pressurized Packaging (Aerosols), (A Herzka and J Pickthall), *review* by Dr V G W Harrison, 1437
Preston, Prof R D Biological Fibres, B A 25
Presumed Glossopteridean Fructifications in Rhodesia and Nyasaland Occurrence of (Dr William S Lacey), 1592
Prevalence (High), of High-Level β-Amino-*iso*butyric Acid Excretors in Micronesians (Dr B S Blumberg and Dr S M Gartler), 1990
Preventing Juvenile Delinquency, 1203
Prevention of Foetal Development by Enzyme Inhibition (Prof G Kahlson and Elsa Rosengren) 1238
Prevention of the Onset of Seed Dormancy by Gibberellic Acid (Dr M Black and J M Naylor), 468, *erratum*, 857
Priborostroenie To be produced under the title *Instrument Construction* (translated from the Russian) (British Scientific Instrument Research Association), 592
Prey Birds of, *review* by Sir Landsborough Thomson, 1435
Priapulid (Abyssal) *Priapulus abyssorum*, New Species, the first (Robert J Menzies), 1585
Priapulus abyssorum, New Species, the first Abyssal Priapulid (Robert J Menzies, 1585
Price, Dr C H G A Seasonal Rhythm in the Presentation of Bone Sarcoma in Man, B A 76
Price, Dorothy (edited by) Dynamics of Proliferating Tissues (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Price, Dr D E, and others Absorption of Zinc Phosphide Particles, 642
Price, Dr D J Appointment as visiting professor of the history of science in Yale University, for the academic year 1959-60, 95
Price, Prof J M, and others 8-Hydroxyquinaldic Acid, the Red Fluorescent Substance in the Urine of Pyridoxine-deficient Rats, 1573
Price, S A, and others Tocopherols in Micro-organisms, 1339
Priede Dr D (Austen, Dr A E W and) Recent Studies of Noise Problems (Physical Acoustics—Diesel Engine Noise), 415
Priestley, M B Fluctuation Phenomena and Stochastic Processes (Detecting a Signal containing several Harmonic Components in the presence of Background Noise), 509
Primaquine-sensitive Erythrocytes (Normal and) Characteristics of Glucose-6-phosphate Dehydrogenase from (Glucose-6-phosphate Dehydrogenase and Human Erythrocytes), (Dr Henry N Kirkman), 1291
Primaries Colour-Image Synthesis with Two Unorthodox (Arthur Karp), 710
Primary Processes indicated by the Flash Technique (Reductive Photobleaching of Eosine), (Shunji Kato and Masao Koizumi), 1620
Primavesi, G R Analysis of Light Hydrocarbons, 2010
Primer Explosion Triggers Reaction (G Larikov), 447
Prince, Dr Morton B, and Wolf, M Awarded the Marconi Premium of the British Institution of Radio Engineers, 857
Principal Magnetic Moments of Co^{++} Ions Temperature Variation of the, and the Asymmetry of the Crystalline Electric Field in Cobalt Acetate Tetrahydrate (Dr Bhagawati Charan Guha), 50
Principle (Hormonal) Natriferin a New in the Neurohypophysis of certain Vertebrates (J Maetz, F Morel and R Lahlouh), 1236
Principle (Transforming), of *Bacillus subtilis* Incorporation of 5-Bromouracil into, and its Biological Effects (Dr Erela Ephrati-Elizur and Prof Stephen Zamenhof), 472
Principles of Electrolysis (Prof C W Davies), *review* by Dr V Gold, 1902
Principles of Electronics (Prof M R Gavin and Dr J E Houldin), *review* by Prof D G Tucker, 751
Principles of Electrophoresis (Rene Audubert and Serge de Mende), translated by A J Pomerans, *review* by Dr R Consden 84
Principles of Geochemistry (Prof Brian Mason), second edition, *review* by Dr S R Nockolds, 1601
Principles of Humane Experimental Technique (Dr W M S Russell and R L Burch), *review* by Prof M Weatherall, 1675
Principles of Modern Physics (Prof Robert B Leighton), *review* by Dr E Stanley, 1438
Principles of Oxidation and Reduction (Dr A G Sharpe), *review* by Dr V Gold, 1902
Principles of Statistical Techniques (P G Moore), *review* by W J Langford, 1523
Principles (Active), of the Neurohypophysis of Cold-blooded Vertebrates—Chromatographic and Biological Characteristics of Fish and Frog Neurohypophysial Extracts (B T Pickering and Prof H Heller), 1463 , Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464 , Arginine Vasotocin (Panayotis G. Katsoyannis and Prof Vincent du Vigneaud), 1465
Principles (Scientific), of Crop Protection (Hubert Martin), fourth edition, *review* by F C Bawder, 1258
Principles and Practice of Crop Protection, *review* by F C Bawden, 1258
Printing Dispute *Nature* and the Recent, 919
Printing Types and Formats Effects of, on the Comprehension of Scientific Journals (E C Poulton), 1824
Prinzie Dr A and others Infectivity of Polio Virus Ribonucleic Acid for Embryonated Eggs and Unsusceptible Cell Lines, 652
Priroda Articles dealing with Space Projectiles launched in the Soviet Union, 771
Private Philanthropic Foundations Grants for, during 1957 (United States National Science Foundation, Reviews of Data on Research and Development, No 15), 1272
Privy Council Committee of Appointment of Sir Hugh Linstead as House of Commons member of the Medical Research Council, 772
Probability Chance and (British Association for the Advancement of Science, Section J (Psychology), Discussion on), 497
  Some Aspects of Analysis and (Irving Kaplansky, Marshall Hall, Jr, Edwin Hewitt and Robert Fortet), *review* by D G Kendall, 214
Probing Behaviour of *Aedes aegypti* (L) in Response to Heat and Moisture (L Burgess), 1968
Problem of Distribution Relict Fauna of Ennerdale Water—a (Dr W. Pennington), 1421
Problem of Viscoelasticity A Molecular Approach to the (Prof Alfred H. Nissan and H G Higgins), 1477
Problem (Few-Nucleon) International Conference on Nuclear Forces and the (Dr T C Griffith and E A Power), 1113
Problems Under-developed Territories and their, 1519
Problems in Chemical Kinetics and Reactivity Some (N N Semenov), Vol I (translated by Michael Boudart), *review* by Dr T M Sugden, 299
Problems of Sex Grants-in-aid for Research in (United States National Academy of Sciences—National Research Council), 1107
Problems and Education Handicapped Children in Britain—their (compiled by W A Axford), (Library Association), 1777
Problems (Administrative), in Expanding Universities (Home Universities Conference, 1959), 1613
Problems (Basic), in Propulsion (Combustion and Propulsion Panel of the Advisory Group for Aeronautical Research and Development Discussion on) 779
Problems (Biological), arising from the Control of Pests and Diseases (Institute of Biology Symposium on), 1100
Problems (Educational), of the Commonwealth, 747
Problems (Management), in Under-developed Countries, 483
Problems (Mental Health), in Old Age (World Health Organization of the United Nations, Technical Report Series No 171), 1844
Problems (Noise) Recent Studies of (Acoustics Group of the Physical Society Symposium on), 414
Problems (Scientific Man-power), in Britain, 1971
Procedures (Diazotization), used in Biological Assay Systems Interference by Azide with (J R Villanueva), 549
Process (Szilard-Chalmers), in Solids Influence of Crystal Defects on the (Dr A G Maddock and J I Vargas), 1931
Processes Thermonuclear (Institution of Electrical Engineers and the British Nuclear Energy Conference Convention on), 240
Processes (Catalytic), and Petroleum, *review* by Dr David M Wilson, 1090
Processes (Condensation), for the Extraction of Radioactivity from Air (Rama), 1789
Processes (Electrode) Influence of Gold in a Mercury Electrode on certain (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus), B A 56
Processes (Magnetic) The Visualization of (Prof L F Bates), B A 41
Processes (Primary), indicated by the Flash Technique (Reductive Photobleaching of Eosine), (Shunji Kato and Masao Koizumi), 1620
Processes (Regeneration) Interaction of Plant Growth Regulators in (H Schraudolf and Prof J Reinert), 465
Processes (Stochastic) Fluctuation Phenomena and (Physical Society Conference on), 509
Processing (Chemical), of Nuclear Fuels (Dr F S Martin and Dr G L Miles) *review* by Dr J E Littlechild, 1346
Processing Mixtures containing Anhydrous Aluminium Chloride A New Method for Working up (Dr T Szell and A Furka), 117, *erratum*, 595
'Procinyl' Dyes (Imperial Chemical Industries, Ltd), 152
Proctor, Dr M H Awarded an Overseas Scholarship by the Royal Commission for the Exhibition of 1851, 409
  A Function for the Extracellular Polysaccharide of *Azotobacter vinelandii*, 1934
Proctor, Nancy G Science by the Upper Form, 597
Produce Malignant Change with Deoxyribonucleic Acid from Rat Sarcoma and Hepatoma An Attempt to (Dr J G Bearn), 824
Product (The Coloured), of the Sakaguchi Reaction (Kshirod R Bhattacharya), 53
Production The Computer in (Institution of Mechanical Engineers Discussion on), 1613
  Tree Fruit (Dr James S Shoemaker and Dr Benjamin J E Teskey), *review* by Prof H W Miles, 487
Production of an Agglutinating Auto-Antibody (Panagglutinin) Active upon Tanned Erythrocytes in the Rabbit (P O Hubinont, P Ghysdael and O Thys), 1250
Production of Amylase by *Penicillium chrysogenum* Inhibitory Effect of Fungistatic Antibiotics on the (Dr I Horvath and A Szentirmai), 57
Production of Colicine by Single Bacteria (H Ozeki, Dr B A D Stocker and Helene de Margerie), 337
Production of Colicines in Simmons s Citrate Agar (Dr J Papavassiliou), 1339

Production of Emetic Material by Species of *Fusarium* (Neville Prentice, A D Dickson and Prof J G Dickson), 1319
Production of Ethylene by Mitochondria from Tomatoes (Prof Mary S Spencer), 1231
Production of Fungal Arbuscular Organs on Laboratory Media (G A Atkins), 1738
Production of γ- and α-Globulins by the Isolated and Perfused Rat Spleen (Dr E Espinosa), 1801
Production of Odd-Numbered Carbon Fatty Acids from Propionate by Mice (Prof S B Tove), 1647
Production of Œstrogen in the Ovary of the Rat Site of (Dr Bengt Falck), 1082
Production of a Perfect Stage in a Nutritionally Deficient Mutant of Pathogenic *Fusarium oxysporum* after Ultra-violet Irradiation (E W Buxton), 1258
Production of all the Rare Earth Metals (Johnson, Matthey and Co , Ltd), 683
Production of Seedless Hops by Interspecific Pollination (Prof Edward L Davis), 1336
Production of Serum Albumin and of Globulins by Chick Mesenchymal Tissue and by HeLa Tumour Tissue in Culture (Y Abdel-Samie, Prof E Broda, G Kellner and W Zischka) 361, *erratum*, 943
Production (Antibiotic), as a Function of Spore Formation in *Bacillus licheniformis* (Robert W Bernlohr and G D Novelli), 1256
Production (Citric Acid), by *Aspergillus niger* Effect of Sulphanilamide on (K V Rajagopalan, R Radhakrishnamurthy and P S Sarma), 461
Production (Experimental), of Magnesium Deficiency in Lambs on a Diet containing Roughage (Dr D M McAleese and Dr R M Forbes), 2025
Production (Light-induced), of Carotenoid Pigments by *Cephalosporia* (R C Codner and B C Platt), 741, *erratum*, 1108
Production (Pigment), by Pseudomonas Enhancement of (Dr A M Paton), 1254
Production (Refinery), 1957 and 1958 United Kingdom Petroleum Industry Statistics relating to Consumption and (Petroleum Information Bureau), 855
Production (Thermoregulatory Heat), in the Brain (Prof Sz Donhoffer, Gy Szegnari I Jarai and M Farkas), 993
Production (Tumour), in Plants by Plant Extracts (Dr Archana Sharma), 1083
Production Facilities New Research and, at Ciba (A R L), Ltd (R F Webb), 601
Productivity Grass (Andre Voisin), translated from the French by Catherine T M Herriot, *review* by Dr W Davies, 1675
Productivity (Grassland) The Measurement of (Sixth Easter School in Agricultural Science at the University of Nottingham School of Agriculture), 154
Productivity Measurement in Great Britain (T E Easterfield), 592
Products (Clay) Permanent Moisture Expansion of, on Natural Exposure (J S Hosking and H V Hueber), 1373
Products (Fission) Biogeochemical Enrichment of (Prof Pontus Ljunggren), 912
Products (Food) The Chemical Analysis of Foods and (Dr Morris B Jacobs), third edition, *review* by Dr V H Booth, 1347
Products (Natural) The Chemistry of, Vol 1, The Alkaloids (K W Bentley) , Vol 2, Mono-and Sesquiterpenoids (P de Mayo) , Vol 3, The Higher Terpenoids (P de Mayo), *review* by Prof A J Birch, 754
  Steric Effects of the Chemistry and Biochemistry of (Biochemical Society Symposium on), 947
Prof The—a Personal Memoir of Lord Cherwell (Sir Roy Harrod), *review* by Prof R V Jones, 1752
Profession of Government (Dr Brian Chapman), 1087
Profession of Government—the Public Service in Europe (Dr Brian Chapman), 127
Professional Societies (Learned and), in Britain Taxation of, 1343
Proflavine Effect of, on the Formation of the Virus of Foot-and-Mouth Disease and its Infective Ribonucleic Acid in Pig Kidney Tissue Culture Monolayers (F Brown and Doreen L Stewart), B A 74
Progeny of the Migratory Locust Maternal Control of Ovariole Number in the (F O Albrecht, M Verdier and R E Blackith), 103
Progesterone Maintenance of Pregnancy in Ovariectomized Ewes by means of (N W Moore and L E A Rowson), 1410
Progesterone and Œstrogen Seasonal Changes in the Œstrous Response by the Ovariectomized Ewe to (Prof J I Raeside and M F McDonald), 458
Progress Partnership for—International Technical Co-operation (Annals of the American Academy of Political and Social Science, May 1959), *review* by R Brightman, 1673
Progress in Biophysics and Biophysical Chemistry (edited by Prof J A V Butler and Prof B Katz) Vol 9, *review* by P A Merton, 1092
Progress of Chemical Engineering in Britain (Sir Hugh Beaver), 408
Progress in Chromatography, Electrophoresis and related Methods Chromatographic Reviews— (edited by Michael Lederer), Vol I, *review* by Dr R Consden, 1436
Progress in Coke Research in Great Britain, 1778
Progress in Dielectrics (edited by Dr J B Birks and Dr J H Schulman), Vol I, *review* by Dr V Daniel, 1175
Progress in Gas Chromatography (C G Scott), 1199
Progress in Industrial Microbiology (edited by Dr D J D Hockenhull), Vol I, *review* by Dr N Blakebrough, 1598
Progress in Nuclear Energy Series 6, Biological Sciences, Vol 2 (edited by J C Bugher, J Coursaget and J F Loutit), *review* by Prof G Pontecorvo, 1902,
  Series 7, Medical Sciences, Vol 2 (edited by J C Bugher, J Coursaget and J F Lutit), *review* by Dr N M Blackett, 1766
Progress in Organic Chemistry (edited by Dr J W Cook), Vol 4, *review* by Dr K H Overton, 1439
Progress in Physiology, *review* by Prof D C Harrison, 838
Progress in Polymer Chemistry Recent (Prof H Mark), 156
Progress of Public Education in the United States of America (1957-58), 418
Progress of Rubber Technology Annual Report on the (edited by Dr T J Drakeley), (Institution of the Rubber Industry), 854
Progress of Satellite $1958\delta_2$ (*Sputnik III*) The Continued (B R May and D E Smith), 765
Progress in Semiconductors (edited by Dr Alan F Gibson, Prof R E Burgess and Prof P Aigrain), Vol , 3, *review* by Dr R A Hyman, 1754
Progress (Some Recent), in the Analytic Theory of Numbers (Prof H Davenport), 1533
'Progressive Mutation induced in *Poa protensis* L by Ionizing Radiation (A A Hanson and F V Juska), 1000
Projectiles Space, launched in the Soviet Union (Articles in *Priroda* dealing with), 771
Prolactin in the Cowbird's Pituitary in relation to Avian Brood Parasitism (Prof E O Hohn), 2030
Proliferating Donor Cells in Chick Embryos injected with Adult Chicken Blood Cytological Identification of (P M Biggs and L N Payne), 1594
Proliferating Tissues Dynamics of (edited by Dorothy Price), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Proline *in vitro* Hydroxylation of (Dr M Chvapil and J Hurych), 1145
Prolonged Survival of Dystrophic Mice treated with 17α-Ethyl-19-Nortestosterone (Dr Robert M Dowben), 1966
Prolonged Thyroid Administration Effect of, on Aged Male Rats (Prof John F Lhotka, Lloyd Glenn McArthur and Arthur A Hellbaum), 1149
Promethium-147 in Rats Hormone Effects on Early Distribution and Disappearance from the Blood of (Dr Bergene Kawin), 1816
Promethium Plasma Fractions in Rats Distribution of (Dr Bergene Kawin), 1722
Promoting Effect of Urea on the *in vitro* Passive Sensitization of Isolated Plain Muscles with Precipitating Antibody (R Binaghi, Dr B N Halpern, P Liacopoulos and T Neveu), 1905
Proof of the Formation of Enzyme-Substrate Complex by 'Crossing-Paper Electrophoresis' (Prof S Nakamura, K Takeo, I Sasaki and M Murata), 638
Prop, Dr F J A Organ Cultures of Total Mammary Glands of the Mouse, 379
Propagation of Ultrasonic Waves in Liquids (Prof A K Dutta, M Subudhi and K Samal), 352
Propagation (Tropospheric Radio) Inadequacy of Scatter Mechanisms in (P C M de Belatini), 1558
Propellants Chemistry of (Combustion and Propulsion Panel of the Advisory Group for Aeronautical Research and Development Discussion on), 778
Proper Study of Mankind is Man (Sir James Gray), B A 35
Properties of Damaged Endothelial Cells Some (Dr J R O'Brien), 1580
Properties of 1-Glyceryl-2-*myo*-inositol Phosphate Synthesis and (Dr T Malkin), 789 , Synthesis of 1-Glyceryl-2-*myo*-inositol Phosphate (J H Davies and Dr T Malkin), 789 , 1-Glyceryl-2-*myo*-inositol Phosphate—Alternative Synthesis and Behaviour on Hydrolysis (R B Ellis and J N Hawthorne), 790
Properties of Liquids, *review* by Prof H C Longuet-Higgins, 1901
Properties of Porous Materials The Structure and—Proceedings of the Tenth Symposium of the Colston Research Society held in the University of Bristol, 1958 (edited by D H Everett and F S Stone), *review*, 1525
Properties (Alkaline-denaturation) A Haemoglobin with Unusual, in a Turkish-Cypriot Woman (Dr J E O'N Gillespie, Dr J C White, M J Ellis, Dr G H Beaven, W B Gratzer, Dr E M Shooter and R M E Parkhouse), 1376
Properties (Biological), of Coal and Coal Extracts (Dr A A Mills), 1885
Properties (Biological), of Phenols of Plant Origin, *review* by Dr F A Robinson, 486
Properties (Biological and Physical) Turnip Yellow Mosaic Virus Nucleoprotein Particles with differing (R E F Matthews), 530
Properties (Flow), of Blood and other Biological Systems (British Society of Rheology and the Colloid and Biophysics sub-Committee of the Faraday Society Discussion on), 322, 1539
Properties (Optical), of Semi-Conductors (Dr T S Moss), *review* by Dr R A Hyman, 1754
Properties (Photochemical and Stereochemical), of Carotenoids at Low Temperatures (Staff of the Biological Laboratories of Harvard University)—Photochemical Behaviour of Retinene (Dr Lawrence Jurkowitz), 614 , *Cis-trans* Isomerism and Steric Hindrance (John N Loeb, Paul K Brown and Prof George Wald), 617 , Discussion (Prof George Wald), 620
Properties (Physical), of Materials Relationship between Structure and (Non-Destructive Testing Group of the Institute of Physics and the Societé Française de Metallurgie Discussion on), 1688
Properties (Physical), of Mucin Molecular Shape and (R A Gibbons), 610
Properties (Reaction-directing), of Non-enzymic Macromolecules—Pyrogallol Oxidation in the System Iron (III)–Cellulose (N S Goodman and S M Siegel), 53
Properties (Redox), of some Dipyridyl Quaternary Salts (R F Homer and T E Tomlinson), 2012
Properties (Some Enzymatic), of Suspensions of Parenchymatous Liver Cells (Dr Keith S Henley, Ole Sorensen and H Marvin Pollard), 1400
Properties (Some Semi-conductive), of Dilute Binary Solid Solutions of Bismuth in Tellurium and Tellurium in Bismuth (Dr Tomasz R Piwkowski), 355
Properties (Surface) Evidence for a Hydrate of Cellulose from Studies of its (Dr J M Joubert, Dr G J R Krige and Dr K Borgin), 1561
Properties (Thermodynamic), of Organic Compounds Some Remarks on the (Prof George S Parks) 1194
Properties and Inheritance of Haemoglobin by Asymmetric Recombination (Dr Harvey A Itano and Elizabeth Robinson), 1468
Property (Anthelminthic), of *Artemesia monosperma* grown in Egypt *In vitro* Study of the (A Sharaf, Z F Ahmed and F Abdel Moneim), 647
Prophylactic Effects of Amine Oxides in Radiation Injury in Mice (Dr Thomas J Haley, Dr Anna M Flesher and Dr Nathan Komesu), 198
Prophylaxis of Poisoning by Carbon Tetrachloride (C H Gallagher and R A Simmonds), 1407
Propionate Production of Odd-Numbered Carbon Fatty Acids from, by Mice (Prof S B Tove), 1647
Propionate Side-Chains of Haematin Decrease in Acid Strength of, on Reduction to Haem (Dr J E O'Hagan), 1808
Propionic Acid (α-Amino-β-(pyrazolyl-N))—a New Amino-Acid from *Citrullus vulgaris* (Water Melon), (Dr F F Noe and Dr L Fowden), B A 69

Proprioceptive Centres (Higher) Possible Role of, in the Perception of Visual Space and in the Control of Motor Behaviour (Dr B Gurevitch), 1219
Propulsion Basic Problems in (Combustion and Propulsion Panel of the Advisory Group for Aeronautical Research and Development Discussion on), 779
  Jet, *review* by D G King-Hele, 1346
  Rocket (British Association for the Advancement of Science, Section B (Chemistry), Discussion on), 1264
Prosen, E J Thermodynamics (Experimental Thermochemistry), 1607
Prospects for Nuclear Power (Political and Economic Planning, Broadsheet No 431), 383
Prosser, M V, and Jackson, G A D Induction of Parthenocarpy in *Rosa arvensis* Huds with Gibberellic Acid, 108
Protected Heptapeptide Synthesis of a, related to the Histidine Analogue of Hypertensin II (Dr Dimitrios Theodoropoulos), 1634
Protection Radiation, 939
Protection of Ancient Buildings, Society for the (Central Council for the Care of Churches and the) Report on the Conservation of English Wallpaintings, 1119
Protection (Crop) The Principles and Practice of, *review* by F C Bawden, 1258
  The Scientific Principles of (Hubert Martin), fourth edition, *review* by F C Bawden, 1258
Protection (Cysteine), against Radiation Cataract Possible Mechanism of (A Pirie and L G Lajtha), 1125
Protective Action of Interferon against Infection with West Nile Virus Duration of (Dr Alick Isaacs and Margueirte A Westwood), 1232
Protective Effect of Foreign Bone Marrow in Lethally X-Irradiated Mice Abrogation by Injected Mouse Blood of (L J Cole and R M Garver), 1815
Protein Binding of Haem to, in Haemoglobin and Myoglobin (Dr J E Falk, Dr J N Phillips and Dr D D Perrin), 1651, (Dr J E O'Hagan), 1652
Protein for Cultivation of HeLa Cells Discarded Blood Bank Blood as a Source of (Billy R Blakey and Prof George E Gifford), 1158
Protein of Human Serum Denatured with Tannin Effect of Ultrasound on the (Dr Wizold Mizgalski and Irena Zygmunt), 1486
Protein from Insoluble Protein-Tannin Compounds Regeneration of (Dr W Mejbaum-Katzenellenbogen, W Dobryszycka, J Boguslawska-Jaworska and B Morawiecka), 1799
Protein (Actomyosin-like), from Human Thrombocytes Extraction of an (M Bettex-Galland and Dr E F Luscher), 276
Protein (D-Amino-Acid Oxidase Apo-) Binding of the Sulphydryl Group in, with Flavin Adenine Dinucleotide (Dr Kunio Yagi and Takayuki Ozawa), 1227
Protein (Bacterial Flagellar) ε-N-Methyllysine in (R P Ambler and M W Rees), 56
Protein (Dietary), and Serum Cholesterol in Rats (A P de Groot), 903
Protein (Johnin) Preparation of a Highly Purified Carbohydrate-free (E Annau), 1642
Protein (Serum) Changes in the Level of, during Treatment of Kwashiorkor (Dr Olumbe Bassir), 2019
Protein (Total), from Wheaten Flour Extraction of the, in the Form of Soluble Derivatives (E E McDermott and Dr J Pace), 546
Protein (Virus) Kinetics of, and Ribonucleic Acid Biosynthesis (Replication of Tobacco Mosaic Virus), (Prof Barry Commoner, Dr James A Lippincott and Dr Janey Symington), 1992
Protein Biogenesis Specificity in (Centre Interuniversitaire de Recherches enzymologiques Colloquium on), 1198
Protein Biosynthesis and Oxidative Phosphorylation in Isolated Rat Liver Mitochondria (P J Reis, J L Coote and T S Work), 165
Protein Depletion Effect of, on the Distribution of Protein Synthesis (Dr John Waterlow), 1875
Protein Molecules The Shape of, suggested by Electron Microscopy (Dr R C Valentine), 1838
Protein Percentage (Dietary) Influence of, on Growth of Wool (K A Ferguson), 907
Protein Synthesis (Dr P M Bhargava), 1368
  Effect of Protein Depletion on the Distribution of (Dr John Waterlow), 1875
Protein Synthesis in Macrophages containing *Eimeria tenella* (Dr G A Gresham and J G Cruickshank), 1153
Protein Synthesis in *Mycobacterium smegmatis* Effect of Iron and Zinc on Nucleic Acid and (Frank Winder and Joan M Denneny), 742
Protein-bound Peptides as exemplified by Oxytocin and Vasopressin Gel Filtration as a Method for Purification of (E B Lindner, Dr A Elmqvist and Dr J Porath), 1565
Protein-Tannin Compounds (Insoluble) Regeneration of Protein from (Dr W Mejbaum-Katzenellenbogen, W Drobyszycka, J Boguslawska-Jaworska and B Morawiecka), 1799
Proteins Action of Anhydrous Formic Acid on Peptides and (H Kienhuis, G Blasse and J Matze), 2015
  The Structure and Chemistry of (Commonwealth Scientific and Industrial Research Organization Symposium on), 1276
Proteins in Aqueous Polymer Phase Systems Counter-Current Distribution of (Per-Ake Albertsson and Ed Jacques Nyns), 1465, *erratum*, 1688
Proteins exposed to Ionizing Radiations in the Solid State Disorganization of the Secondary Structure in (Dr Peter Alexander, L D G Hamilton and Dr K A Stacey), 226
Proteins in *Escherichia coli* Influence of DL-beta-Phenylserine on the Synthesis of (J Janeček, J Chaloupka, K Vereš and M Havranek), 1895
Proteins (Glyco-) of Human Cerebrospinal Fluid (Dr Samuel Bogoch), 1628
Proteins (Normal Soluble), in Guinea Pig Liver Agar Electrophoresis of (Prof Iv Goranov, Y Todorov, X Skatshokova, M Hlebarova and P Kuzmanova), B A 64
Proteins (Polypeptidyl), and Synthetic Polypeptides Immunochemical Studies of (Prof M A Stahmann, D J Buchanan-Davidson, Dr C Lapresel and Dr P Grabar), 549
Proteins (Substituted Human Serum) Modifications in Immunological Behaviour, Electrophoretic Mobility and Colourability of (M Steinbuch, Dr J M Fine and A Battistini), 1571
Proteinuria (Bence Jones), associated with a Transplantable Mouse Plasma-Cell Neoplasm (John L Fahey and Michael Potter), 654, *erratum*, 1108
Proteus Lysogeny in the Genus (Prof J N Coetzee and T G Sacks), 1340
Proteus P 18 Distribution of Nucleic Acids among Different Stable *L* Forms of (Prof P Mandel, M Sensenbrenner, P De Gregorio and A M Bader), 566
Prothoracic Gland Stimulation by Juvenile Hormone Extracts of Insects (Dr Lawrence I Gilbert and Dr Howard A Schneiderman), 171
Prothrombin (Purified Human) Activation of Staphyloccal-free Coagulase by (G Haughton and E S Duthie), 116
Proton and Neutron (Electron,) A Comparison of the Charges of the (A M Hillas and T E Cranshaw), 892, (Prof H Bondi and Dr R A Lyttleton), 974
Proton Linear Accelerator at the Rutherford High Energy Laboratory, 94
Proton Resonance Relaxation Times in Mobile Liquids (Dr J G Powles and D Cutler), 1123
Proton Synchrotron *Nimrod* (7,000-MeV) Contracts for work on the (National Institute for Research in Nuclear Science), B A 14
Proton-Transfer Nature of some Changes in Keratin and the Analogy with Muscle Contraction Permanent Set, Supercontraction and Urea-Bisulphite Solubility—the (Dr P T Speakman) 339
Protoparce sexta (Johan), (Tobacco Hornworm), and the Colorado Potato Beetle, *Leptinotarsa decemlineata* (Say) Common Attractant for the (Dr Robert T Yamamoto and Prof G Fraenkel), 206
Protoplasts (Naked), of Yeasts Nuclear Structure of Growing (Dr O Necas), 1664
Protoplasts (Streptococcal) Formation of Streptolysis *S* by (Dr Yoshiharu Maruyama, Sadako Sugai and Prof Fugio Egami), 832
Protozoa (Rumen) Hydrogenation of Lipids by (Dr D E Wright), 875
  Isolation of 2-Amino-ethane Phosphonic Acid from (Masaaki Horiguchi and Makoto Kandatsu), 901
Protozoologists, United States Society of Election of Officers for 1959-60, 1272
Prout, E G (Herley, P J, and) Thermal Decomposition of Irradiated Lead Oxalate, 445
Providing United States Scientists with Soviet Scientific Information (United States National Science Foundation), revised edition, 1611
Provision of Supervisors and Managers Management Development, a Systematic Approach to the (F I de la P Garforth), 319
Proximate Analysis of Marine Standing Crops (Dr T R Parsons and Dr J D H Strickland), 2038
Przemieniecki, Dr J S Structural Effects of Kinetic Heating (The Design of Transparencies), 31
Przybykski, A Ionization Phenomena in Gases (Measurements of the Absorption Coefficients in Oxygen and Nitrogen of Gas-ionizing Radiation produced by Corona Discharges in the same Gases), 1354
Pseudomonas Enhancement of Pigment Production by (Dr A M Paton), 1254
Pseudomonas aeroginosa Effect of Ultra-Violet Irradiation on Transduction in (J S Loutit), 1960
  Transduction in (Dr B W Holloway and Marilyn Monk), 1426
Pseudomonas solanacearum Comparison of Slime from Tomato and Banana Strains of (Dr W F Dudman), 1969
Pseudopleuronectes americanus (Winter Flounder) Failure of Corpuscles of Stannius from, to Synthesize Adrenocorticosteroids *in vitro* (Dr J G Phillips and Dr P J Mulrow), 558
Pseudoscorpioniden-Fauna des Andengebietes Zur Kenntnis der (Max Beier), (Beiträge zur Neotropischen Fauna), *review* by Dr F A Turk, 1177
Pseudotsuga menziesii (Mirb) Franco Seedlings Response of *Sequoia sepervirens* (D Don) Endl and, to Temperature (Henry Hellmers and William P Sundahl), 1247
Psittacosis Elementary Bodies (F L Constable), 473
Psychology at Sheffield, 93
Psychology of Social Class (Maurice Halbwachs), translated by Claire Delavenay, *review* by Prof T S Simey, 754
Psychology (Industrial), National Institute of Grant of £6,000 a year for five years from the Department of Scientific and Industrial Research, 940
  Vernon Prize for 1960, 1450
Psychopharmacologia, Vol I, Fasc I, 940
Puberulonic Acids (Stipitatonic and) Tropolone Biosynthesis—the Enzymatic Decarboxylation of (Prof Ronald Bentley and Clara P Thiessen), 552
Public Education in the United States of America Progress of (1957-58), 418
Public Expenditure Control of, 857
Public Health Aspects of Nuclear Energy Post-Graduate Training in the (World Health Organization, Technical Report Series No 154), 33
Public Health Service (United States) Grant of 14,160 dollars to the University of Oxford, for the continuation of research on vision and light quanta, 943, 1273
  Grant of 30,600 dollars to the University of Oxford, for research in the Department of Biochemistry, 1362
Public Libraries (Rate Supported) in Great Britain and Northern Ireland Statistics of, 1957-1958 (Library Association), 592
Public Service in Britain Scientists in the—Special Promotions, 858, 1273
Public Service in Europe The Profession of Government—the (Dr Brian Chapman), 127
Public Services in a Modern Democracy The Development of, 1087
Publications (Scientific) Distribution of, in Under-developed Countries (Scientific Publications Council Discussion on), B A 22
Publications (Scientific), of South and South-East Asia Bibliography of (Unesco Science Co-operation Office), Vol 5, No 6, 772
Puccinia kraussiana Cooke Pachytene in, on *Smilax kraussiana* (Dr Eva Sansome), 1820
Puffinus tenuirostris Experimental Demonstration of an Internal Rhythm of Reproduction in a Trans-Equatorial Migrant, the Short-tailed Shearwater (Dr A J Marshall and Dr D L Serventy), 1704
Pugwash International Conference of Scientists—Statement on Biological and Chemical Warfare, 1018
Puig Muset, P, and others Radiomimetic Action of Lipoxidase, 1506
Pulmonary Megakaryocytes A Possible Explanation of the Formation of Long Platelets from (Dr J George Sharnoff), B A 75
Pulse Conditions (Microsecond) Conduction Currents in Liquid *n*-Hexane under (A Harry Sharbaugh and P Keith Watson), 2008

Pulses (Strong), of Ionic Current Effects of the Energy of, in Micro-organisms in Suspension (B S Gossling), 1881
Pump (Boyle's Air) Robert Hooke and (Dr H D Turner), 395
Pupal Periods of some Lepidopterous Insects Relationship between Larval and (Dr M A Zaher and Dr Moufied A Moussa), 289
Purcell, J D, and others Lyman-Alpha Photographs of the Sun 8
Purchon, Prof R D University of Malaya in Kuala Lumpur 306
Pure Culture of the Pathogenic Agent of Tyzzer's Disease of Mice (Dr K Kanazawa and A Imai), 1810
Pure Metals Spectrographically (Prof W Hume-Rothery), 1794
Pure and Applied Chemistry, International Union of Meeting of the Commission on Geochemistry, 1193
  Election of members of the Commission on Geochemistry, 1193
  Election of Prof C W Correns as president for 1960 of the Commission on Geochemistry, 1193
Pure and Applied Chemistry, International Union of (Committee of the Analytical Chemistry Section) Nomenclature in Titrimetric Analysis, 1686
Pure and Applied Chemistry, International Union of (Commission on Macromolecules) International Symposium on Macromolecules, 1689
Pure and Applied Chemistry, International Union of (Deutsche Bunsengesellschaft fur Physikalische Chemie and the) Symposium on Thermodynamics, 1606
Puri, G S Origin and Dispersal of Flowering Plants (Himalayas invaded by Conifers during the Pleistocene Glaciation), 1200
Purification River (F T K Pentelow) 94
Purification of Enzymes (Dr B K Bachhawat), 1368
Purification of Herpes Simplex Virus by Chromatography of Calcium Phosphate (Janice Taverne and Peter Wildy), 1655
Purification of Nitrate Reductase from Embryos of Germinating Wheat Isolation and (D Spencer), 682
Purification of Protein-bound Peptides as exemplified by Oxytocin and Vasopressin Gel Filtration as a Method for (E B Lindner, Dr A Elmqvist and Dr J Porath), 1565
Purification of 'Queen Substance' from Queen Bees Extraction and (Dr C G Butler, Dr R K Callow and Norah C Johnston), 1871
Purified Human Prothrombin Activation of Staphylococcal-free Coagulase by (G Haughton and E S Duthie), 116
Purified (Highly) Carbohydrate-free Johnin Protein Preparation of a (E Annau), 1642
Purified (Highly) Sample of the Urinary Gonadotrophin Preparation of a (Roland Bourrillon, René Got and Rene Marcy), 983
Purine and Pyrimidine Analogues Effect of, on Reversion of a Tryptophan-requiring Strain of *Escherichia coli* (C O Doudney and F L Haas), 114
Purine Nucleotides of Red Lateral Muscle of Rainbow Trout Changes in (Tsuneyuki Saito, Ken-ichi Arai and Toshikatsu Yajima), 1415
Purity (High-) Aluminium Analysis for Magnesium in (C A Youngdahl and F E DeBoer), 54
Purkinje Nerve Cells of some Mammals Sex Chromatin ('Chromoleme') in the (Nylceo Marques de Castro and Wilson da Silva Sasso), 293
Purkis, H J Recent Studies of Noise Problems (Human Response to Noise—Community Reaction to Noise), 414
Purnell, Dr J H Comparison of Efficiency and Separating Power of Packed and Capillary Gas Chromatographic Columns, 2009
Purves, Dr David Implications of Restricting Cows to a Clover-free Diet in order to Reduce the Strontium Content of Milk, 1408
Putzeike, E, and others Energy Transfer with special reference to Biological Systems (Properties of Isolated Chlorophyll), 690
Puzzle-Math (Prof George Gamow and Dr Marvin Stern), *review* by Prof T A A Broadbent, 217
Pyelonephritis in Mice An Experimental Enterococcal (Dr Arvid L Erlandson, jun, Dr Leola A Gagliardi and Dr Myron W Fisher), 561
Pyrah, A E (Allen, W D, and), and others The Tandem Generators of the United Kingdom Atomic Energy Authority, 303
Pyrethrum Resistance conferred by Resistance to DDT in the Blue Tick (G B Whitehead), 378
Pyridine Nucleotide (Mitochondrial) Fluorescence Measurements of, in Aerobiosis and Anaerobiosis (Localization and Assay of Respiratory Enzymes in Single Living Cells), (Prof Britton Chance and Dr Bo Thorell), 931
Pyridine Nucleotide Oxidase from Heart Sarcosomes Corticosterone Inhibition of (P K Jensen), 451
Pyridoxal Phosphate, a Coenzyme for Histidine Decarboxylase (S Ono and Prof P Hagen), 1143
Pyridoxine Deficiency Rat Brain Glutathione and (M J Ashwood-Smith and A D Smith), 2028
Pyridoxine-deficient Rats 8-Hydroxycuinaldic Acid the Red Fluorescent Substance in the Urine of (Dr J K Roy, Dr R R Brown and Prof J M Price), 1573
Pyrimidine Analogues (Purine and) Effect of, on Reversion of a Tryptophan-requiring Strain of *Escherichia coli* (C O Doudney and F L Haas), 114
o-Pyrocatechuic Acid Conversion of Salicylic Acid to Gentisic Acid and, all Labelled with Carbon-14, in Plants (Dr Ragai K Ibrahim and Prof G H N Towers), 1803
Pyrogallol Oxidation in the System Iron (III)–Cellulose Reaction-directing Properties of Non-enzymic Macromolecules— (N S Goodman and S M Siegel), 53
Pyruvic Acid in Blood, Cerebrospinal Fluid and Urine α-Ketoglutaric Acid and (Dr E Zelnicek), 727

QUADRUPOLE Anti-Shielding Factor in Copper (E A Faulkner), 442
Quagliariello, Prof E, and others An Antimetabolic Action of Vitamin K, 820
Quality in Merino Wool Routine Methods for determining (P L le Roux), 917
Quality Control (Quality Control Group of the Textile Institute Conference on), B A 16
Quality Control in Electronics Sixth National Symposium on Reliability and, 1362
Quantitative Assay of Compounds in Isolated, Fresh Nerve Cells and Glial Cells from Control and Stimulated Animals (Prof Holger Hydén), 433
Quantitative Changes in γ-Aminobutyric Acid induced by Low Temperature in Rice Plants (F Zsoldos), 280
Quantitative Determination Occurrence and, of 2-Dimethylaminoethanol in Animal Tissue Extracts (Dr Conrad G Honegger and Ruth Honegger), 550, *erratum*, 1986
Quantitative Estimation of the Fatty Acids of Olive Oil (J Gracian, E Vioque and Mª Pilar de la Maza), 1941
Quantitative Paper Chromatography based on the Sub-Micro Titration of Derivatives containing Nitro Groups (L Blom and J Caris), 1313
Quantitative Study of the Surface Precipitation Reaction A Method for the (Francis T Ashton), 1735
Quantities (μgm) of Iron in Culture Medium Estimation of, using Bathophenanthroline (P A. Seamer), 636
Quantities (Observed) A Least-Squares Solution for a Linear Relation between Two (P A Wayman), 77 (B K Kelly) 1086
Quantity (Light) Fusion Frequency and (A Angel, D A Hems, W Rose, R C Woledge and Dr R A Weale), 1873
Quantum Electrodynamics Experimental Tests of (Prof W E Lamb), 954
Quarries and Mines Aerial Photographs of (Exhibition at the Geological Museum, London), 855
Quastel, Prof J H (Kini, M M, and) Carbohydrate—Amino-Acid Interrelations in Brain Cortex *in vitro*, 252
Quaternary Ecology (Linnean Society of London Symposium on), 1535
Quaternary Salts (Dipyridyl) Redox Properties of some (R F Homer and T E Tomlinson), 2012
Queen Bees Extraction and Purification of 'Queen Substance' from (Dr C G Butler, Dr R K Callow and Norah C Johnston), 1871
Queen Elizabeth College, London The new Sir John Atkins Laboratories, 26
Queen Mary College, London Appointment of E M Rawstron as reader in geography, 322
  Symposium on the Oxidation of Organic Compounds, 326
  Appointment of Dr A Ashmore to the University of London readership in experimental physics, 595
'Queen Substance' from Queen Bees Extraction and Purification of (Dr C G Butler, Dr R K Callow and Norah C Johnston), 1871
Queen's College, Dundee Appointment of Dr A J O Cruickshank as reader in electrical engineering, 684
  Appointment of Dr J L Copp as senior lecturer in chemistry, 684
  Appointment of W McNicoll as senior lecturer in civil and mechanical engineering, 684
  Appointment of Dr F Walker as senior lecturer in geology, 684
Queen's University, Belfast Appointment of Dr C J M Stirling as lecturer in organic chemistry, 322
  Appointment of Dr J S Pate as lecturer in botany, 322
  Appointment of Dr B V Jayawant as lecturer in electrical engineering, 322
  Appointment of N C Mitchel as lecturer in geography, 322
  Appointment of W D Ryan as lecturer in light electrical engineering, 322
  Appointment of Dr F J Wallace as senior lecturer in mechanical engineering, 1613
  Appointment of L J Clein as lecturer in mental health, 1613
Quelea quelea Duration of the Regeneration Period of the Internal Reproductive Rhythm in a Xerophilous Equatorial Bird (H J de S Disney, B Lofts and Dr A J Marshall), 1659
  Effect of Photoperiod on the Gonadal Cycle in an Equatorial Bird (Dr Albert Wolfson and David P Winchester), 1658
Quenching and Tempering The Phenomena occurring in Steels during (Academic an G V Kurdjumov), 1450
Quennell, A M, and others Summary of the Geology of Tanganyika, Part I, Introduction and Stratigraphy, 1688
Quenouille, M H The Fundamentals of Statistical Reasoning, *review* by Dr D J Finney 217
Quick Method for Extracting Plant Embryos from certain Types of Seed (M D Gwynne), 1588
Quiescence or Diapause Dormancy of the Khapra Beetle— (H D Burges), 1741
Quinnat Salmon Stomach Contents of Spawning (J S Bullivant), 71

RAAL, Dr F A (Mutch, R E, and) Electrical Resistivity Changes observed in a Semiconducting Diamond after Heat Treatment, 1857
Rabbit Production of an Agglutinating Auto-Antibody (Panagglutinin) Active upon Tanned Erythrocytes in the (P O Hubinont, P Ghysdael and O Thys), 1250
  A Specific Response in the Hippocampus of the, to Olfactory Stimulation (B G Cragg), 1697
Rabbit γ-Globulin *Iso*-Antigens of (S Dubiski, Danuta Skalba, Anna Dubiska and Dr A Kelus), 1811
Rabbit Ova Fertilization of, *in vitro* (Dr M C Chang), 466
Rabbit-pox Virus Antiviral Chemotherapeutic Activity of Isatin β-thiosemicarbazone in Mice infected with (D J Bauer and F W Sheffield), 1496
Rabbit's Long Bones Glutamic-Pyruvic Transaminase in (L Tessari and L Parrini), 904
Rabbits Asymmetrical Delivery in (Dr Luiz Macedo Costa and Dr Arpad Csapo), 144
  A Seasonal Sex Difference in the Infestation of, with the Nematode *Trichostrongylus retortaeformis* (Zeder, 1800), (P C Bull), 281
Rabbits (Alloxan-Diabetic) A Low Concentration of certain Blood Constituents observed in Offspring of (Dr Otakar Sirek and Dr Anna Sirek), 456
Rabbits (Papain-injected) Cartilage Homografts in (M B L Craigmyle), 1243
Rabbits (Wild) Age Determination in (R H Taylor), 1158
Rabenau, Dr A, and Eckerlin, Dr P Special Ceramics (A New Hexagonal Form of Be_3N_2), 1116
Rabinowitch, Prof B, and Brody, Dr S S Energy Transfer with special reference to Biological Systems (Energy Migration in Photosynthesis), 689
Rabinowitch Prof Eugene, and others Statement on Biological and Chemical Warfare, 1018
Rabinowitz, I N (Bernstein, I B, and) Ionization Phenomena in Gases (Velocity Distribution of Plasma Electrons in an External Magnetic Field), 1357

Races (Local), in Lugworms, *Arenicola marina* (L), (Dr A Duncan), 71
Radar (Ground-Based) Use of in Meteorology (excluding Upper-Wind Measurements), (World Meteorological Organization, Technical Note No 27), 942
Radar Echoing Area Polar Diagrams of Birds (J Edwards and E W Houghton), 1059
Radd, Dr F J Crack Behaviour at a Weld Structure Discontinuity, 543
Radd, Dr F J , and Crowder, L H Solid State Rheological Study of the Mechanism of Paraffin-Detergent Interactions in Aqueous Systems, 443
Radd, Dr F J , and Qertle, Donald H Strength Impairment Mechanism of Glass in Aqueous Systems 976
Radd, Dr F J , and others Relationship of pH to Aerobic Corrosion Fatigue Life of Steel, 2008
Radhakrishnamurthy, R , and others Effect of Sulphanilamide on Citric Acid Production by *Aspergillus niger*, 461
Radiation, a Tool for Industry (National Industrial Conference Board, Inc , seventh Annual Conference on Atomic Energy in Industry), 506
Radiation Colour Centres produced by, in Silica Gel (Harold W Kohn), 630, *erratum*, 1026
γ-Radiation Effect of, on the Synthesis of Methanol over Zinc Oxide (T I Barry and R Roberts), 1061
γ-Radiation from Deposited Fall-Out (D H Peirson and L Salmon), 1678
γ-Radiation (Background), in Leeds during 1955-59 Some Measurements of (Prof F W Spiers), 1680
Radiation (Cerenkov), and its Applications (Dr J V Jelley), *review*, 1260
Radiation (Enhanced), on 200 Mc /s Correlation between the Intensity of the Umbra of Sunspots and (Per Maltby), 1391
Radiation (Enhanced Solar Radio) Observations of the Fine Structure of with a Narrow-Band Spectrum Analyser (Oystein Elgaroy), 887
Radiation (High Energy) Estimation of Chain Fracture and Cross-Linking of Rubber by (P Hayden) 1865
Radiation (Ionizing) Cross-linking of Cellulose Acetate by (Dr S H Pinner, T T Greenwood and D G Lloyd), 1303
  A 'Progressive' Mutation induced in *Poa pratensis* L by (A A Hanson and F V Juska) 1000
  A Sensitive Chemical Dosimeter for (Prof Gerald Oster and Dr Barret Broyde), 545
Radiation from Jupiter Anomalous Continuum (Dr Eugene E Epstein), 52
Radiation Balance at Scott Base (D C Thompson and W J P Macdonald), 541
Radiation Belt and the Solar Wind The Aurora, the—a Unifying Hypothesis (M H Rees and G C Reid), 539
Radiation Belts (Van Allen) The Upper Boundary of the (Dr Conway W Snyder), 439
Radiation Cataract Possible Mechanism of Cysteine Protection against (A Pirie and L G Lajtha), 1125
Radiation Injury in Mice Prophylactic Effects of Amine Oxides in (Dr Thomas J Haley, Dr Anna M Flesher and Dr Nathan Komesu), 198
Radiation Leukaemia Dose–Response Relationship in (Dr P Armitage, Dr W M Cort Brown and Dr R Doll), 1669 , (Dr D J Mewissen), 1670
Radiation Measurements to 658,000 km with *Pioneer IV* (Prof James A Van Allen and Louis A Frank), 219
Radiation Observations with Satellite 1958δ over Australia (Dr A J Herz, Dr K W Ogilvie, J Olley and R B White), 391
Radiation Protection, 939
Radiation Safety and Health Physics (J W Lucas), 329
Radiation Syndrome The Acute—a Medical Report on the Y-12 Accident, 1958 (compiled by Dr Marshall Brucer), (United States Atomic Energy Commission, Report ORINS-25), 1022
Radiations (Ionizing) Advice concerning Hazards from (Ministry of Housing and Local Government, Circular No 57/59), 1450
  Biological Effects of Low Doses of (Unesco, the International Atomic Energy Agency and the Comitato Nazionale per le Ricerche Nucleari Symposium on), 1111
  Cross-Linking of Deoxyribonucleic Acid in Sperm Heads by (Dr P Alexander and Dr K A Stacey), 958
  Degradation of Thiotaurine by (D Cavallini, B Mondovi, B Giovanella and C De Marco), B A 61
  Disorganization of the Secondary Structure in Proteins exposed to, in the Solid State (Dr Peter Alexander, L D G Hamilton and Dr K A Stacey), 226
  Immediate and Low-level Effects of (Dr Tikvah Alper), 1111
  Waterways and, 1450
Radicals Free—an Introduction (A F Trotman-Dickenson), *review* by Dr T M Sugden, 1259
Radicals (Free), in Coal during Carbonization at Different Heating Rates Number of (J Smidt and Prof D W van Krevelen), 719
Radicals (Free), as Studied by Electron Spin Resonance (Dr D J E Ingram), *review* by Dr T M Sugden, 1259
Radicals (Free), in X-Rayed Seeds of High and Low Water Content, as Measured by Electron Spin Resonance (Dr W Klingmuller, Dr G R Lane, M C Saxena and Dr D J E Ingram), 464
Radio Astronomers International Conference of, *review* by Dr H P Palmer, 1755
Radio Astronomy Paris Symposium on, 1958 (edited by Ronald B Bracewell), *review* by Dr H P Palmer, 1755
Radio Astronomy Observatory, United States National Appointment of Prof Otto Struve as first director, B A 14
Radio Bursts (Slow-Drift Solar) Geomagnetic Disturbance and Velocity of (M B Wood and C S Warwick), 1471
Radio Echo Observations of Venus (J V Evans and G N Taylor), 1358
Radio Engineers, British Institution of Clerk Maxwell Premium awarded to C Powell and D A Hendley, 857
  Heinrich Hertz Premium awarded to K Foster, 957
  Sir Louis Sterling Premium awarded to Dr A van Weel, 957
  Sir J C Bose Premium awarded to Dr B Ramachandra Rao, Dr M Srirama Rao and C Abhirama Reddy, 857
  Brabazon Premium awarded to Prof D G Tucker, Dr V G Welsby, R Kendall and D E N Davies, 857
  Marconi Premium awarded to Dr Morton B Prince and M Wolf, 857
Radio Field-Strengths in the Tropics, 605
Radio Industry Council and the Electronic Engineering Association Premiums for articles on Electronics, 943
Radio Noise Effect of Atomic Tests on (C A Samson), 538
Radio Noise from the Outer Atmosphere Directional Observations of (G R A Ellis and D G Cartwright), 1307
  Spaced Observations of (G R A Ellis, D G Cartwright and J R V Groves), 1391
Radio Noise (Low-Frequency) (100 kc /s), from the Aurora (R L Dowden), 803
Radio Outbursts Association of, with Solar Flares (L D de Feiter, A D Fokker and J Roosen), 805
Radio Propagation (Tropospheric) Inadequacy of Scatter Mechanisms in (P C M de Belatini), 1558
Radio Radiation (Enhanced Solar) Observations of the Fine Structure of, with a Narrow-Band Spectrum Analyser (Oystein Elgaroy), 887
Radio Research, 1024
Radio Research Board Special Report No 28, The Conversion of Ionospheric Virtual Height-Frequency Curves to Electron Density-Height Profiles (Dr J O Thomas and M D Vickers), 1024
Radio Signals at Ionospheric Heights Refraction of Very High Frequency (S Weisbrod and L Colin) 119
Radio Source (Cygnus-A) Red-Shift Absorption Spectrum of the (Dr R D Davies and Dr R C Jennison), 803
Radio Telescope The Ohio State University 350-ft (Prof John D Kraus), 669
Radio Telescope for Australia, 93
Radioactivation Analysis (International Atomic Energy Agency and the International Council of Scientific Unions Symposium on), 951
Radioactive Barium in Eye Tissues Distribution of (R J Garner), 733
Radioactive Exchange Labelling of Rose Bengal with Iodine-131 by (J Liebster and O Andrysek), 913
Radioactive Iodine Affinity of Lysozyme with Structural Elements of the Bacterial Cell as studied with Enzyme Labelled with (Prof C Weibull, B Zacharias and H Beckman), 1744
Radioactive Iodine in Thyroid Glands Accumulation of, subsequent to Nuclear Weapon Tests and the Accident at Windscale (Dr Hamish A Robertson and Ian R Falconer), 1699
Radioactive Ionization Type Detector Analysis of Permanent Gases by Gas Chromatography using a (V Willis), 894
Radioactive Materials Glove Boxes and Shielded Cells for Handling—a Record of the Proceedings of the Symposium on Glove Box Design and Operation held in the Cockcroft Hall, A E R E , Harwell, 1957 (edited by G N Walton), *review*, 1599
Radioactive Particles (Autoradiographed) Electron Microscopy of (L A George, II , and G S Vogt), 1474
Radioactive Phosphorus An Effect of Dose Fractionation on the Incidence of Bone Tumours using (Dr N M Blackett), 565
Radioactive Raw Materials Mineralogy and Geology of (Prof E Wm Heinrich), *review* by Prof C F Davidson, 1262
Radioactive Waste Disposal of (K Saddington and W L Templeton), *review*, 301
Radioactivity from Air Condensation Processes for the Extraction of (Rama), 1789
Radioactivity in Erythrocytes of Different Ages Enzymes and (Dr Lester M Levy, Harry Walter and Martin D Sass), 643
α-Radioactivity of Cerium-142 (F E Senftle, T W Stern and V P Alekna), 630
Radiocarbon Dating (British Association for the Advancement of Science, Sections A (Mathematics and Physics) and H (Anthropology), Discussion on), 672
Radiocarbon Dating (*American Journal of Science*, Radiocarbon Supplement, Vol I), 1686
Radiocarbon Dating of the Piltdown Skull and Jaw (Prof H de Vries and Dr K P Oakley), 224
Radiocarbon Dating of Prehistoric Wooden Trackways (Dr H Godwin and Dr E H Willis), 490
Radiochemical Tracer Study of the Relative Stability of the Halogenoplatinates (A J Poe and M S Vaidya), 1139
Radiochemistry (published in the Russian language by the Academy of Sciences of the U S S R), 410
Radiochemistry Advances in Inorganic Chemistry and (edited by H J H J Emeléus and A G Sharpe), Vol I, *review* by Dr D W A Sharp, 1756
Radiofrequency Methods Molecular and Atomic Motions in Liquids and Solids by (Colloque AMPERE and the Radiofrequency Spectroscopy Group Joint Discussion on), 157
Radiofrequency Spectroscopy Group (Colloque AMPERE and the) Joint Discussion on Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 157
Radioiron in Man Biological Half-Life of (R Oliver and Dr L G Lajtha), 1882
Radioisotopes Course on the basic techniques of handling (United States Atomic Energy Commission), 771
Radioisotopes in Agricultural Research The Use of (Ministry of Food and Agriculture of the Government of India, Food and Agriculture Organization of the United Nations, International Atomic Energy Agency and Unesco South East Asia Science Co-operation Office Course on), 1451
Radiological Hazards to Patients—Interim Report of the Committee (Ministry of Health and the Department of Health for Scotland) 162
Radiomimetic Action of Lipoxidase (P Puig Muset, J Martin Esteve and J Valls Mateu), 1506
Radionuclides in Air and in Water for Occupational Exposure Maximum Permissible Body Burdens and Maximum Permissible Concentrations of (United States National Bureau of Standards, Handbook 69), 939
Radiophosphorus Effect of Acetylcholine on the Incorporation of, into the Phosphatido-Peptide Fraction of Pancreas Slices (Prof C G Huggins), 1412
Radioprotective Action of Methoxamine (A D Smith, Dr M J Ashwood-Smith and Doreen Lowman), 1729
Radiosentivity of the Intact Mouse Spleen Decrease in, produced by Hypozia (Dr L Weiss), 1156
Radiosensitivity of Mice Importance of the Type of Metabolism for the (Dr M Pospisil and Dr L Novak), 1814
Radio-Telemetry of Nerve Action Potentials Amplitude-Modulation (Roger M Morrell), 1129

Radiotherapy High-Pressure Oxygen and, 94
Radiozinc Behaviour of Zinc and, in Tumour-bearing Rats (Dr D M Taylor), 1649
Rado, P Special Ceramics (Preparation and Properties of Calcium Fluoride), 1116
Radok, Dr Uwe Temperatures in Polar Ice Caps, 1056
Rae, D M (read by) Special Ceramics (Measurement of Creep at High Temperature, by N L Parr and G F Martin), 1116
Raeside, Prof J I, and McDonald, M F Seasonal Changes in the Œstrous Response by the Ovariectomized Ewe to Progesterone and Œstrogen, 458
Raether, H Ionization Phenomena in Gases (Current Growth and Avalanches of Large Amplification), 1354
Raffkina, L I, and others Various Types of Acquired Resistance to Experimental 'Allergic' Encephalomyelitis, 1552
Rafflesia arnoldi in Sumatra (W Meijer), 506
Raftery, M (ÓhEocha, Dr C, and) Photoreactive Pigments in Flagellates—Phycoerythrins and Phycocyanins in Cryptomonads, 1049
Ragle, J L Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Rai, U K A 40-Chromosome Variant in *Solanum nigrum* L, 1587
Rain-Forest Zone (Nigerian) Non-Symbiotic Nitrogen Fixation in a Soil of the (Dr A W Moore and J N Abaelu), 75
Rainwater Potassium/Sodium Ratio in (B C V Oddie), 1791
Rain Water collected in the Humid Central Congo Basin Nitrogen Content of (J Meyer and E Pampfer), 717
Rainbow Trout Changes in Purine Nucleotides of Red Lateral Muscle of (Tsuneyuki Saito, Ken-ichi Arai and Toshikatsu Yajima), 1415
Rains, A H J Appointed to the chair of surgery in Charing Cross Hospital Medical School, London, 322
Raja clavata A Functional Interpretation of the Electron-Microscopic Structure of the Sensory Hairs in the Cristae of the Elasmobranch, in Terms of Directional Sensitivity (Prof O Lowenstein and J Wersall), 1807
Rajagopalan, K V, and others Effect of Sulphanilamide on Citric Acid Production by *Aspergillus niger*, 461
Rajam, Dr P C, and Jackson, Anne-Louise *In vitro* Labelling of Antibody Globulin by Tritium Exchange, 375
Ram, Dr Manasi Occurrence of Embryo Sac-like Structures in the Microsporangia of *Leptomeria billardierii* R Br, 914
Rama Condensation Processes for the Extraction of Radioactivity from Air, 1789
Ramakrishnan, T (Sastry, L V S, and) Biochemical Research in India (New Type of Enzymatic Transamination Reaction in which Glyoxylate Transaminates with a number of Amino-Acids to produce Glycine), 1368
Ramasarma, Dr T Coenzyme Q, 1368
Rammell, C G Tallowy Discoloration in Cheddar Cheese—Fat Oxidation and Haematin Systems in Cheese, 1296
Rampion, *Campanula rapunculus* L Carbohydrates of the (Dr J D S Bacon), 1957
Ramsay Memorial Fellowships Trustees Awards of new Fellowships in Chemistry for 1959-60, B A 16
Ramsbottom, Dr J Conception of Evolution—Meeting in Paris, 859
Ramsey, H W (Gennaro, jun, Prof J F, and) Distribution in the Mouse of Lethal and Sub-Lethal Doses of Cottonmouth Moccasin Venom labelled with Iodine-131, 1244
Ramsey, Dr N F Chemistry of Propellants, 778
Ramshaw, Dr C, and Thornton, Dr J D Droplet Circulation and Interfacial Disturbances in Gas–Liquid Systems, 719
Rand, M J (Burn, Prof J H, and) Sympathetic Postganglionic Mechanism, 163
Randle, P J (Battaglia, F C, and) Monosaccharide Transport in Rat Diaphragm Muscle, 1713
Rangaswami, Dr G (Satyanarayana, G, and) Effect of Indole Acetic Acid and α-Naphthalene Acetic Acid on the Growth, Flowering and Fruit Set in Sweet Potato, B A 73
Range (Daily), of the Geomagnetic Vertical Intensity around the Magnetic Equator Possible Asymmetry in the (Dr C A Onwumechilli), 51
Ranvier in Potassium-rich Solutions Action Potentials from Single Nodes of (Dr Hans-Christoph Luttgau), 1494
Rao, Dr B Ramachandra, and others Awarded the Sir J C Bose Premium of the British Institution of Radio Engineers, 857
Rao, Dr M Srirama, and others Awarded the Sir J C Bose Premium of the British Institution of Radio Engineers, 857
Rao, N Appaji, and others Biochemical Research in India (Occurrence of Flavin Nucleotides in Plants and the Changes in their Concentration with Germination of Green Gram and Cow Pea), 1368
Rapid Estimation of the Specific Surface of a Powder (Dr H E Rose and R M E Sullivan), 46
Rapid Infra-red Technique Post-Exposure Analysis of Organic Compounds in the Blood by a (Dr R D Stewart, D S Erley, T R Torkelson and C L Hake), 192
Rapid Method for Studying Tumour Blood Supply using Systemic Dyes (Dr R J Goldacre and Dr B Sylven), 63
Rapid and Sensitive Method for the Determination of Xanthine Oxidase Activity using the Oxygen Electrode (Metry Bacila and Dr Gilberto G Villela), 1394
Rapid and Simple Pathogenicity Test for Detecting Virulent Clones of *Fusarium oxysporum* f *cubense* using Seedlings of *Musa balbisiana* (Dr R H Stover), 1591
Rapoport, Dr Anatol The Road to Knowledge (The Language of Science), B A 7
Rapoport, Lorence (edited by Edwin M Smolin and) *s*-Triazines and Derivatives (The Chemistry of Heterocyclic Compounds, Vol 13), *review* by Dr F G Mann, 1758
Rappaport, Dr Irving Recovery of Infectious Nucleic Acid from Tobacco Mosaic Virus inactivated by Antibody, 1732
Rappoport, Prof D A, and Sewell, B W Metabolic Changes induced in Mammalian Erythrocytes by Whole-Body X-Irradiation, 846
Rare Earth Metals Production of all the (Johnson, Matthey and Co, Ltd), 683
Rare Hydromedusa A (Surg Comdr D C Howe), 1963
Rashevsky, Dr Nicolas The Road to Knowledge (Mathematical Principles in Biology), B A 6
Rasky, K Origin and Dispersal of Flowering Plants (Angiosperms in various Tertiary Floras of Hungary), 1201
Rat Carbonic Anhydrase in the Deciduoma of the (Dr T H Johnson, Dr C Lutwak-Mann and Prof M C Shelesnyak), 961
  Effect of Adrenalectomy on the Hormone Content of the Thymus in the (Dr J Comsa), 279
  Effect of Dietary Fat and Extent of Blood Sampling on the Level of Plasma Cholesterol in the (I Coleman and J M R Beveridge), 1039
  Effect of Ethylenediamine Tetra-acetate on Vitamin B_{12} Absorption in the (Edward G Rice Dr Samuel M Greenberg, John F Herndon and E J Van Loon), 1948
  Influence of the Thymus upon the Egg-White Allergy in the (Dr J Comsa), 1726
  Occurrence of Polynucleotide Phosphorylase in Atypical Epithelioma of (Dr Kunio Yagi, Takayuki Ozawa and Hiroshi Konogi), 1939
  Relation of Ethanol Metabolism to Several Factors in the (Dr F W Kinard, J C Aull, jun, and R E Ulmer), 1721
  Residual Bodies of Seminiferous Tubules of the (B V Kingsley Smith and Dr D Lacy), 249
  Site of Production of Œstrogen in the Ovary of the (Dr Bengt Falck), 1082
Rat with 'Sugar' Cataract Formation of Polyols by the Lens of the (Dr Ruth van Heyningen) 194
Rat (Infant) Passage of Insulin through the Wall of the Gastro-intestinal Tract of the (Dr B Mosinger, Z Placer and O Koldovsky), 1245
Rat (Male) Effect of Sexual Maturation and Castration on the Sex Chromatin Pattern in the (St Zsifkovits, Ch Mehes and C Jobst), 1239
Rat (Multimammate) Is the, a Natural Reservoir of *Borrelia duttoni*?, (Dr F Zumpt), 793
Rat (White) Effect of 'Amino-Acid Imbalance' on Growth and Vitamin A Storage in the (M Rechcigl, jun, S Berger, J K Loosli and H H Williams), 1404
Rat Adrenal Lipids Use of Porter–Silber and Schiff Reagents as Spot Tests for Steroids applied on Paper and their Application to the Study of (Dr Marion K Birmingham), B A 67
Rat Brain Histochemical Study of Monoamine Oxidase in the Developing (Nobuo Shimizu and Nogaaki Morikawa), 650
  Increase in the γ-Aminobutyric Acid Content of, after Ingestion of Ethanol (Dr H -M Hakkinen and E Kulonen), 726
  Noradrenaline and Adrenaline in the, during Acute and Chronic Morphine Administration and during Withdrawal (Dr Lars-M Gunne), 1950
Rat Brain Glutathione and Pyridoxine Deficiency (M J Ashwood-Smith and A D Smith), 2028
Rat Diaphragm Salicylate and Potassium Fluxes of (Dr J A Hicklin), 2029
Rat Diaphragm *in vitro* Role of Magnesium in the Insulin-Sensitivity of the (Dr Gangagobinda Bhattacharya), 1401
Rat Diaphragm Muscle Monosaccharide Transport in (F C Battaglia and P J Randle), 1713
Rat Kidney Deaminases of Adenylic Acid and Adenosine in (Dr M Zydowo), 1641
Rat Liver Mitochondria A Cardiolipin-like Compound in (G S Getz and W Bartley), 1229
  Formation of Noradrenaline from Adrenaline by (Dr Kunio Yagi and Dr Toshiharu Nagatsu), 1316
  Pantothenic Acid Deficiency and Ubiquinone Levels in (A S Aiyar, G A Sulebele, D V Rege and A Sreenivasan), 1867
Rat Liver Mitochondria (Isolated) Protein Biosynthesis and Oxidative Phosphorylation in (P J Reis, J L Coote and T S Work), 165
Rat Mast Cells Release of Histamine from, by Blood treated with Dextran (Dr G T Archer), 1151
Rat Oral Tissue Effect of Vitamin D on the Respiration of (L Zar and Prof J T Irving), 1410
Rat Sarcoma and Hepatoma An Attempt to produce Malignant Change with Deoxyribonucleic Acid from (Dr J G Bearn), 824
Rat Serum (Acidified) Peptides with Oxytocic and Pressor Activity obtained from (Prof H Croxatto, T Pereda and R Mellada), 1496
Rat Spleen (Isolated and Perfused) Production of γ- and α-Globulins by the (Dr E Espinosa), 1801
Rat Tail Tendon Collagen Chromatographic Fractionation of (Alexander Kessler, Hyman Rosen and Dr Stanley M Levenson), 1640
Rat Tissues Histological Localization of Fluorescent Thyroid-stimulating Hormone in (Dr E E Mancini, O Vilar, J M Dellacha, A Gimeno and A Castro), 1733
Rat Uterus (Isolated) Some Pharmacological Effects of Staphylolysin on the (Dr B Wiegershausen), 2017
Rat Ventricle Preparation Potentiation of Contractions after Rest in the Isolated (Dr R L Speirs), 66
Ratcliffe, J A Recent Trends in the Theory of the Ionosphere (Presidential Address to the Physical Society), 419
  Re-elected president for 1959-60 of the Physical Society, 420
  Fluctuation Phenomena and Stochastic Processes (Stochastic Problems arising in Radio Physics), 511
Rate of Appearance of Mutants with Respiration-deficiency in *Staphylococci* (G F Gause, G V Kochetjova and N A Sorbaeva), 1821
Rate of Growth of Wool Measurement of the, using Cystine labelled with Sulphur-35 (A M Downes and A G Lyne), 1884
Rate of Reductive Photo-bleaching Effect of Added Substances on the (Reductive Photo-bleaching of Eosine), (Kengo Uchida, Shunji Kato and Masao Koizumi) 1620
Rate of Setting of Gypsum Plaster Effect of Temperature on the (M J Ridge), 47
Rates (Relative), of Exchange of Potassium-42 by the Foetal Metanephros and Foetal Liver (Dr J G Bearn and Dr F T C Harris), 1959
Rating of Charities and Kindred Bodies Report of the Committee on the, 1343
Ratio of Nucleon Mass and Electron Mass (Prof A J Rutgers), 894
Ratios (Saliva-Serum), of Deuterium Oxide after Administration of Heavy Water (Nan Taggart and Dr F E Hytten), 457
Rats Application of Biometrical Genetics to Behaviour in (Dr P L Broadhurst), 1517
  Attempts to Modify the Normal Metabolism of Strontium-90 in (Dr V Volf), 1401
  Dietary Protein and Serum Cholesterol in (A P de Groot), 903

  Distribution of Promethium Plasma Fractions in (Dr Bergene Kawin), 1722
  Fate of the Highly Polymerized Spleen Deoxyribonucleic Acid labelled with Phosphorus-32 Injected Intraperitoneally into (Tamara A Hudnik-Plevnik, Vladimir R Glišin and Marta M Simic), 1818
  Hormone Effects on Early Distribution and Disappearance from the Blood of Promethium-147 in (Dr Bergene Kawin), 1816
  Increased Oxygen Consumption in , during Irradiation (Dr A Vacek), 197
  Pharmacological Suppression of Increased Capillary Permeability following Irradiation of the Intestine of (Dr D A Willoughby), 1156
  Presence of certain Onium Compounds in Brain Tissue following Intravenous Administration to (Prof Ruth R Levine), 1412
  Sex Difference in Ethanol Tolerance of (Henrik Wallgren), 726
Rats with Bile Fistulae Thirst for Bile in (Dr Albert J Bertinchamps, James J Greenough and George C Cotzias), 1405
Rats deficient in Vitamin E Curative Effect of Selenium upon the Incisor Teeth of (Prof J T Irving), 645
Rats (Adrenalectomized) Sodium Chloride Intake and Urinary Histamine in (Dr T Bjuro and Dr H Westling), 1241
Rats (Aged Male) Effect of Prolonged Thyroid Administration on (Prof John F Lhotka, Lloyd Glenn McArthur and Arthur A Hellbaum), 1149
Rats (Fasted) Effect of Whole-body X-Irradiation on the Insulin Resistance of (Dr V Stankovic and N Sestan), 1816
Rats (Normal and Diabetic) Release of Non-Esterified Fatty Acid from Adipose Tissue in (Dr E Wendeová and Dr J Pav), 1147
Rats (Pyridoxine-deficient) 8-Hydroxyquinaldic Acid, the Red Fluorescent Substance in the Urine of (Dr J K Roy, Dr R R Brown and Prof J M Price), 1573
Rats (Tumour-bearing) Behaviour of Zinc and Radiozinc in (Dr D M Taylor), 1649
Rats (WR Strain) A Sex Difference in White Blood Cells of (Dr Hans Meier), 1082
Rats and Mice Thiamine-sparing Action of Sorbitol in (Dr T B Morgan and Prof John Yudkin), 909
Rats and Mice (Newborn) An Improved Technique for Intravenous Injection of (N F Anderson, E J Delorme, Prof M F A Woodruff and D C Simpson), 1952
Raven, Canon Charles E Medicine—Mother of the Sciences (Inaugural Lecture to the Faculty of the History of Medicine and Pharmacy of the Worshipful Company of Apothecaries of London), 1448
Raw, Dr F Estimating Earthworm Populations by using Formalin, 1661
Raw, Dr Isaias, and Colli, Walter Crystalline Cytochrome *b_5*, 1798
Raw, Dr Isaias, and others Methaemoglobin Reduction through Cytochrome *B_5*, 1651
Raw Materials (Radioactive) Mineralogy and Geology of (Prof E Wm Heinrich), *review* by Prof C F Davidson, 1262
Rawlins, F I G The Nature of Experience, *review*, 218
  The Faith of a Realist, *review*, 388
  Toward a Systematic Pragmatics, *review*, 754
  Husserliana Completed, *review*, 1571
Rawstron, E M Appointed reader in geography at Queen Mary College, London, 322
Ray, Amal, and Sadhu, Prof D P Carbohydrate Metabolism in Hypervitaminosis A, 1323
Ray, Francis E (Argus, Prof Mary F, and) Possible Relation between Carcinogenicity and Ease of Hydrolysis *in vitro* of Derivatives of 2-Amino-fluorene, 2018
Ray, Dr N H Carrier Gas and Sensitivity in Gas Chromatography, B A 54
Ray (Cosmic) Energy Spectrum Changes Evidence for, during a Forbush Decrease (K W Ogilvie and M M Winn), 888
Ray (Cosmic-) Storm of February 11, 1958 North–South Anisotropy and Anticipatory Increase of Intensity associated with the (Dr V Sarabhai and R Palmeira), 1204
Raymond, J C, and others Gibberellic Acid and Nodulation of Legumes, 1576
Raynor, Prof G V The Physical Metallurgy of Magnesium and its Alloys, *review* by Dr J W Martin, 486
Rayon Research Association The British—Open Days (L A Wiseman) 600
γ-Rays A Capacitance Method for following Vinyl Polymerizations initiated by (G J K Acres and F L Dalton), 335
Rays (Cosmic), in Space Change of (Prof H V Neher), 423
Rays (Solar Cosmic) Satellite Observations of (Pamela Rothwell and Carl McIlwain), 138
Reaction Primer Explosion Triggers (G Larikov), 447
Reaction to Dental Pain Association between Colour of the Iris of the Eye and (Dr Philip R N Sutton), 122
Reaction of Epinephrine and Norepinephrine with Ethylene Diamine Evidence of Side-Chain Cleavage during the (Dr Louis-P Joly and Dr Guy Nadeau), 1483
Reaction of Formyl Porphyrins with Acetone-Hydrochloric Acid (Dr P S Clezy), 1142
Reaction of Meruric Chloride with Plasmalogen (Dr William T Norton), 1144
Reaction (Biuret) Crystallographic Studies of the (Dr H C Freeman, J E W L Smith and J C Taylor), 707
Reaction (Complex), in *Hyoscyamus niger* upon Night Interruption with Red Light (P J A L de Lint), 731
Reaction (Galactokinase) Equilibrium Constant of the, and Free Energy of Hydrolysis of Adenosine Triphosphate (Dr M R Atkinson, Eleanor Johnson and Prof R K Morton), 1925
Reaction (Grain Boundary), in Aluminium–Zinc Alloys Reversion of Nodules formed by the (Ryoji Watanabe and Shigeyasu Koda), 977
Reaction (Hill) Relationship between Photophosphorylation and the (Dr H E Davenport), 524
Reaction (Homograft) Dietary Factors in the (Dr A S Parkes), 699
Reaction (Photoperiodic), in the Genus *Chenopodium* (Tourn) L Extreme Sensitivity of Germination and (Dr Bruce G Cumming), 1044
Reaction (Sakaguchi) The Coloured Product of the (Kshirod R Bhattacharya), 53
Reaction (Surface Precipitation) A Method for the Quantitative Study of the (Francis T Ashton), 1735
Reaction (Szilard-Chalmers), in Lithium Permanganate (J R Bolton and Prof K J McCallum), 1717
Reaction (Transformation), of Pneumococci in the Absence of Serum Factor (Prof Takeshi Odaka and Tadashi Watanabe), 471
Reaction Kinetics, *review* by Dr T M Sugden, 299
Reaction Technology (Nuclear) Analytical Chemistry in (Third Conference on), 26
Reaction-directing Properties of Non-enzymic Macromolecules—Pyrogallol Oxidation in the System Iron (III)–Cellulose (N S Goodman and S M Siegel), 53
Reactions of the Pacific Sardine *Sardinops caerulea* (Girard) under the Influence of White and Colored Lights and Darkness Behavior and (Dr A S Loukashkin and Dr N Grant), 865
Reactions with Thiols *in vitro* Metabolic and Chemical Studies of 'Myleran' —Formation of 3-Hydroxytetrahydrothiophene-1,1-dioxide *in vivo*, and (Dr J J Roberts and Dr G P Warwick) 1288
Reactions (Colour), of certain Phenols with Ehrlich's Reagent (Dr Cornelius Steelink), 720
Reactions (Electrode), at the Mercury Electrode Influence of Platinum in Mercury on the Mechanism of (Prof Wiktor Kemula, Zenon Kublik and Zbigniew Galus), 1795
Reactions (Fast), in Solids (Dr F P Bowden and A D Yoffe), *review* by Dr Peter Gray, 664
Reactions (Fast Chemical), in Solution (Deutsche Bunsengesellschaft fur Physikalische Chemie and the Max-Planck Gesellschaft Colloquium on), 1453
Reactions (Nuclear), in Cosmical Electrical Discharges The Temperature required for (Dr C E R Bruce), 2004
Reactions (Organic) Tracer Applications for the Study of (John G Burr, Jr), *review* by Dr A I Scott, 1902
Reactivation of Vaccinia Virus Inactivated by Mercury (Colin Kaplan), 1074
Reactivity Some Problems in Chemical Kinetics and (N N Semenov), Vol I (translated by Michael Boudart), *review* by Dr T M Sugden, 299
Reactivity and Interrelationship of Intermediates in the Hydrolysis of *p*-Nitrophenyl Acetate Catalysed by Chymotrypsin (Mario A Marini and Prof George P Hess), 113
Reactor The Halden (Norway), 516, 1844
  Criticality of the Dounreay Fast Breeder, 1449
  Merlin, an Industrial Research (Dr T E Allibone), B A 11
  Neutron Source Thermal, (*Nestor*), to be purchased by the United Kingdom Atomic Energy Authority from the Hawker Siddeley Nuclear Power Co , 1533
Reactor *RB* (Nuclear) Accident in Yugoslavia, 406
Reactor (*Zenith*), at Winfrith Heath (United Kingdom Atomic Energy Authority), 680
Reactor Project at Halden, Norway, 516, 1844
Reactor School Course on the Control and Instrumentation of Reactors Third (Atomic Energy Research Establishment), 1026
Reactors Advanced Gas-cooled (United States Atomic Energy Commission and the United Kingdom Atomic Energy Authority to exchange Technical Information on), 1361
  Third Reactor School Course on the Control and Instrumentation of (Atomic Energy Research Establishment), 1026
  Power (Directory of Nuclear Reactors, Vol I), (International Atomic Energy Agency), *review* by Dr A J Salmon, 1438
Reactors (Neutron Chain) The Physical Theory of (Alvin M Weinberg and Eugene P Wigner), *review* by Dr J Walker, 1973
Reactors (Nuclear) Directory of (International Atomic Energy Agency), Vol I, Power Reactors, *review* by Dr A J Salmon, 1438
Reactors (Nuclear), for Power Generation (edited by E Openshaw Taylor), *review* by R Vaux, 301
Read, Prof John Organic Syntheses, Vol 37, 1957 (edited by James Cason), Vol 38, 1958 (edited by John C Sheehan), *review*, 134
Reagent (Ehrlich's) Colour Reactions of certain Phenols with (Dr Cornelius Steelink), 720
Reagent (Neutral Citrate-Dithionite) Aluminium extracted by (W M H Saunders), 2037
Reagents (Fluorescent Schiff-Type), for Cytochemical Detection of Polyaldehyde Moieties in Sections and Smears (Prof Frederick H Kasten, Vivian Burton and Peggy Glover), 1797
Reagents (Porter–Silber and Schiff) Use of, as Spot Tests for Steroids applied on Paper and their Application to the Study of Rat Adrenal Lipids (Dr Marion K Birmingham), B A 67
Realist The Faith of a, *review* by F I G Rawlins, 388
Reasoning (Statistical) The Fundamentals of (M H Quenouille), *review* by Dr D J Finney, 217
Receptors (Red Blood Cell) Influence of Streptomycin Solutions on the Interaction between the Agglutinating Sera and the Corresponding (Dr M Kout and Dr Z Kubickova), 639
Rechcigl, jun , M , and others Effect of 'Amino-Acid Imbalance' on Growth and Vitamin A Storage in the White Rat, 1404
Recherche Scientifique, Centre National de la Colloques Internationaux, No 84, Acoustique Musicale (Marseilles, 1959), *review* by Prof E G Richardson, 1902
Recherche Scientifique en Afrique Centrale, Institut pour la Dixieme Rapport Annuel (1957), 407
Recherches sur les Affinités Chromosomiques dans le Genre *Coffea* (J Bouharmont), 518
Recherches sur l'Autostérilité du Caféier robusta (*Coffea canephora* Pierre), (M Devreux, G Vallaeys, P Pochet et A Gilles), 518
Recherches Enzymologiques, Centre Interuniversitaire de Colloquium on Specificity in Protein Biogenesis, 1198
Recherches Géologiques, Géophysiques et Minieres, Bureau de (Service d'Information Géologique) A New Geological Documentation Service, 153
Recognition of Diseases and Pests of Farm Crops (Ernst Gram, Prosper Bovien and Chr Stapel), *review* by F C Bawden, 1258
Recoil Damage Annealing of, by Ultra-Violet Light (R F C Claridge and Dr A G Maddock) 1932
Recombination of Parental Biochemical Components in a *Baptisia* Hybrid Population Applications of Paper Chromatography to Systematics — (Dr R E Alston and Dr B L Turner), 285
Recombination (Asymmetric) Properties and Inheritance of Haemoglobin by (Dr Harvey A Itano and Elizabeth Robinson), 1468
Recombination (Atom) Mechanism of (Prof G Porter and Dr J A Smith), 446

Recombinational Lethals in a Polymorphic Population (J B Gibson and Prof J M Thoday), 1593
Recording Eye Movement (G H Byford), 1493
Recording the Positions of Microscopical Objects (Dr J R Baker), 34
Recover Infective 'Ribonucleic Acid' Failure to, from Myxovirus Preparations (G L Ada, Patricia E Lind, Lois Larkin and Sir Macfarlane Burnet), 360
Recovery of Infectious Nucleic Acid from Tobacco Mosaic Virus inactivated by Antibody (Dr Irving Rappaport), 1732
Recovery in Mammalian Cells in Culture X-Ray Damage and (M M Elkind and Harriet Sutton), 1293
Recovery from Whole-Body γ-Irradiation Cells which Synthesize Deoxyribonucleic Acid in Guinea Pig Bone Narrow during (P F Harris and J H Kugler), 1883
Recovery (Bacterial), from Ultra-violet Light Macromolecular Synthesis in (C O Doudney), 189
Recreation Studies in, 1034
Recrystallization of Zone-Refined Lead (G F Bolling), 718
Rectification (Stochastic), of Non-linear Clocks (David G Kendall), 1476
Red Alga (Marine) A Free-Floating (Dr H B S Womersley and Dr R E Norris), 828
Red Blood Cell Receptors Influence of Streptomycin Solutions on the Interaction between the Agglutinating Sera and the Corresponding (Dr M Kout and Dr Z Kubickova), 639
Red Blood Cells Coating of, with Antigenic Substances (Dr K Deutsch), 278
Red Blood Corpuscles Effect of Polyphloretin Phosphate on the Suspension Stability of (Dr Bengt Fries), 62
Red Cells (Duck), *in vitro* Role of Stroma in Haemoglobin Synthesis—Experiments on (A Breccia, A L Fantola, E Lazzarini and A Giustina), 1878
Red Cells (Human) Accumulation of Dextran in, after Haemolysis (N V B Marsden and S G Ostling), 723
  Calcium Ions and the Permeability of (Prof M Maizels), 366
Red Clover (*Trifolium pratense* L) Floral Initiation and its Relationship to Growth-Stage in (J L Stoddart), 559
Red Fluorescent Substance in the Urine of Pyridoxine-deficient Rats 8-Hydroxyquinaldic Acid, the (Dr J K Roy, Dr R R Brown and Prof J M Price), 1573
Red Lateral Muscle of Rainbow Trout Changes in Purine Nucleotides of (Tsuneyuki Saito, Ken-ichi Arai and Toshikatsu Yajima), 1415
Red Light Complex Reaction in *Hyoscyamus niger* upon Night Interruption with (P J A L de Lint), 731
Red Locust Control Service, International Work of the, 589
  Retirement of Dr D L Gunn from the directorship, 589
  Appointment of C du Plessis as director, 590
Red Mite (Citrus), *Panonychus citri* (McG) A Suspected Virus Disease of the (Dr Kenneth M Smith, G J Hills, F Munger and J E Gilmore), 70
Red-Shift Absorption Spectrum of the Cygnus-A Radio Source (Dr R D Davies and Dr R C Jennison), 803
Red Sulphur Bacteria Amino-Acids of (H Mukherjee) 1742
Redd, jun , B L , and others Effects of Irradiation of Nerve on Muscular Response, 734
Reddy, C Abhirama, and others Awarded the Sir J C Bose Premium of the British Institution of Radio Engineers, 857
Rede Lecture for 1959 (Sir Charles Snow), 295, 411
Rediscovery of *Bathynella chappuisi* Delachaux in Britain (Ian Efford) 558
Redish, K A Appointed lecturer in computing at the University of Birmingham, 684, 1362
Redman, Prof R O Astrophysics, *review*, B A 3
  Awarded a grant of £5,500 by the Paul Instrument Fund Committee of the Royal Society, 507
Redox Potentials in Soybean Nodules during the Vegetative Period (Dr Helena Ebertova), 1046
Redox Properties of some Dipyridyl Quaternary Salts (R F Homer and T E Tomlinson), 2012
Reduce the Strontium Content of Milk Implications of Restricting Cows to a Clover-free Diet in order to (Dr David Purves), 1408
Reduced Diphosphorpyridine Nucleotide Effect of on the Swelling of Isolated Mitochondria (Dr G Di Sabato), *erratum*, 95
Reduced Diphosphopyridine Nucleotide Oxidation Inhibition of, by Ammonia (R T Wedding and H M Vines), 1226
Reduced Pressure Habit of Ice Crystals grown in Hydrogen, Carbon Dioxide and Air at (A P van den Heuvel and Dr B J Mason), 519
Reduced Triphosphopyridine Nucleotide-linked Cystine Reductase in the Clothes Moth, *Tineola bisselliella* (Humm), (R F Powning and H Irzykiewicz), 1230
Reductase (Nitrate) Isolation and Purification of, from Embryos of Germinating Wheat (D Spencer) 682
Reductase (Triphosphopyridine Nucleotide-linked Cystine) A Reduced, in the Clothes Moth, *Tineola bisselliella* (Humm), (R F Powning and H Irzykiewicz), 1230
Reductases (Folic Acid) Flavins as Components of (Dr Beatriz M Braganca and U W Kenkare) 1488
Reduction Principles of Oxidation and (Dr A G Sharpe), *review* by Dr V Gold, 1902
Reduction in the Anoestrus Period of Laboratory Cats by Increased Illumination (Dr Patricia P Scott and Marny A Lloyd-Jacob), 2022
Reduction of the $FeS_2O_3^+$ Ion at the Dropping Mercury Electrode (F M Page), 1481
Reduction to Haem Decrease in Acid Strength of Propionate Side-Chains of Haematin on (Dr J E O'Hagan), 1808
Reduction of Toxicity of Cationic Macromolecules by Complexing with Anionic Derivatives of Synthetic Polyglucoses (P T Mora, B G Young and M J Shear), 431
Reduction (Enzymic), of α-Aminoadipic Acid by Yeast Enzyme (S Sagisaka and Prof K Shimura), 1709
Reduction (Methaemoglobin), through Cytochrome B_5 (Nicola Petragnani, Otilia C Nogueira and Isaias Raw), 1651
Reduction (Nitrate), by Aqueous Extracts of Excised Tomato Roots (C S Vaidyanathan and Prof H E Street), 531
Reductive Photo-bleaching Effect of Added Substances on the Rate of (Reductive Photo-bleaching of Eosine), (Kengo Uchida, Shunji Kato and Masao Koizumi), 1620
Reductive Photo-bleaching of Eosine—Primary Processes indicated by the Flash Technique (Shunji Kato and Masao Koizumi), 1620 , Effect of Added Substances on the Rate of Reductive Photo-bleaching (Kengo Uchida, Shunji Kato and Masao Koizumi), 1620
Reed, Dr R , and others A New Approach to the Dating of the Dead Sea Scrolls, 533
Reed, Dr R I Substitution at Elements other than Carbon, *review*, 1262
Reed, Dr R I , and Snedden, W Coal Science (Spectroscopy of Coals—Fragments produced from Aromatic Compounds), 413
Reed, Dr R I (Finan, Dr P A , and) Application of the Mass Spectrometer to Polysaccharide Chemistry 1866
Reed Dr T Edward, and Ahronheim Dr J H An Association between Abo Blood Groups and Fertility in a Normal American Population, 611
Rees, M H , and Reid, G C The Aurora, the Radiation Belt and the Solar Wind—a Unifying Hypothesis, 539
Rees, M W (Ambler, R P and) ε-N-Methyllysine in Bacterial Flagellar Protein, 56
Rees, W H The Chemistry of Clothing (Physical Aspects of Clothing for Comfort), 849
Rees, W T (Parker, Dr C A , and) Photolysis of Thionine in Rigid Medium—Measurement by Spectrofluorimetry, 1223
Reeves, Dr J Wynn Title of reader in psychology in the University of London (at Bedford College) conferred on, 322
Re-examination of Theories A (Replication of Tobacco Mosaic Virus), (Prof Barry Commoner), 1998
Refined Lead (Zone-) Recrystallization of (G F Bolling), 718
Refinery Production, 1957 and 1958 United Kingdom Petroleum Industry Statistics relating to Consumption and (Petroleum Information Bureau), 855
Reflections of a Mathematician (Prof L J Mordell), 681
Reflex (Peristaltic) Are Mucosal Nerve Fibres Essential for the (Dr K H Ginzel), 1235
Reflex Inhibition of Intestinal Motility (Nils G Kock), 1069
Reflex Muscular Responses Does an Increase in the Tension in a Ligament elicit (Dr Bertil Stener), 1495
(III) Reflexion for Diamond Intensity of the (Prof R Brill and H Barth), 264
Reflexion (Direct Continuous-Wave) Apparent Observation of Solar Corpuscular Clouds by (Dr John D Klaus and W Reed Crone), 965
Refraction of Very High Frequency Radio Signals at Ionospheric Heights (S Weisbrod and L Colin), 119
Refrigeration, International Institute of Tenth International Congress of Refrigeration, 946
Rege, D V , and others Pantothenic Acid Deficiency and Ubiquinone Levels in Rat Liver Mitochondria, 1867
Regeneration of Protein from Insoluble Protein-Tannin Compounds (Dr W Mejbaum-Katzenellenbogen, W Dobryszycka, J Boguslawska-Jaworska and B Morawiecka), 1799
Regeneration in Vertebrates (edited by Charles S Thornton), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Regeneration (Shell and Siphon), in *Mactra stultorum* Linne (Lamellibranchiata), (L Birkett and R J Wood), 1075
Regeneration' ('Thermal), in the Nickel-Oxygen System (Prof J S Anderson and D F Klemperer), 899
Regeneration Period of the Internal Reproductive Rhythm in a Xerophilous Equatorial Bird, *Quelea quelea* Duration of the (H J de S Disney, B Lofts and Dr A J Marshall), 1659
Regeneration Processes Interaction of Plant Growth Regulators in (H Schraudolf and Prof J Reinert), 465
Regional Advisory Council (London and Home Counties) for Technological Education Tenth Annual Report, 94
Regional Research Centre of the British Caribbean Soil and Land-Use Surveys, No 1, Parish of St Catherine Jamaica (K C Vernon) , No 2, The Rupuruni Savannas of British Guiana (R F Loxton, G K Rutherford and J Spector) , No 3, St Vincent (J P Watson, J Spector and T A Jones), 27
Regional Research Laboratory, Hyderabad Annual Report for 1957-58, 320
Regional Training Course on Diagnosis, Improvement and Management of Salt-affected Soils (Unesco Middle East Science Co-operation Office), 1778
Regional Training Course for Laboratory Technicians (University Institute of Chemistry, Lahore), 857
Registrar General Statistical Review of England and Wales for the Year 1957, Part 2, Tables, Civil, 1107
Registration of Scientific and Technical Persons (1958), 854
Registration of the Spermicidal Effects of Dioctyl Sodium Sulphosuccinate (Prof Per Eric Lindahl and Kjell Wedin), 1289
Regulation Plant Growth (Boyce Thompson Institute for Plant Research, the New York Botanical Garden and the Brooklyn Botanic Garden fourth International Conference on), 599
Regulation (Light), of Coat-Shedding in a Tropical Breed of Hair Sheep (R B Symington), 1076
Regulation (Self-) in Living Systems (Second Ottawa Symposium on), 239
Regulation (Sodium), in the Blood of Parr and Smolt Stages of the Atlantic Salmon (Prof H J Koch, J C Evans and E Bergstrom), 283
Regulators (Plant Growth) Interaction of, in Regeneration Processes (H Schraudolf and Prof J Reinert) 465
Reichenberg, D Ion Exchange, *review* 1757
Reichstein, Prof T , and others 3 4,ω-Trihydroxyacetophenone 3-methyl Ether in Adrenal Extracts, 268
  Isolation of 24-Methylene-cholesterol from Honey Bees (*Apis mellifica* L), 732
Reid, Dr D D Title of professor of epidemiology in the University of London (at the London School of Hygiene and Tropical Medicine) conferred on, 1108
Reid, G C (Rees, M H , and) The Aurora, the Radiation Belt and the Solar Wind—a Unifying Hypothesis, 539
Reid, jun , Joseph L Evidence of a South Equatorial Countercurrent in the Pacific Ocean, 209
Reinacker, Prof Gunther Elected a member of the Chemistry Section of the Leopoldina Academy of Natural Sciences, 595
Reiner, Dr John M Behavior of Enzyme Systems, *review* by Dr J B Chappell, 388

Reiner, Prof M Flow Properties of Biological Systems 1539
Reiner, Prof M , and Blair, Dr G W Scott The Flow of Blood through Narrow Tubes, 354
Reiners, W J (Entwistle, Alison, and) Incentives in the Building Industry (National Building Studies Special Report No 28), 98
Reinert, Prof L (Schraudolf, H and) Interaction of Plant Growth Regulators in Regeneration Processes 465
Re-Interpretation of Charnockites (A P Subramaniam), 321
Reis, P J , and others Protein Biosynthesis and Oxidative Phosphorylation in Isolated Rat Liver Mitochondria 165
Relation of Ethanol Metabolism to Several Factors in the Rat (Dr F W Kinard, J C Aull, jun , and R E Ulmer), 1721
Relation between Giant Travelling Disturbances and Sporadic E Ionization (L H Heisler), 1788
Relation to Invasive Capacity to Passage of Lymphocytic Cells through Cellulose Membrane Filters (Dr Emma Shelton and Dr Mary E Rice) 479
Relation (Linear), between Two Observed Quantities A Least-Squares Solution for a (P A Wayman), 77 , (B K Kelly) 1086
Relation (Possible), between Carcinogenicity and Ease of Hydrolysis *in vitro* of Derivatives of 2-Aminofluorene (Prof Mary F Argus and Francis E Ray), 2018
Relation (Possible), with an Excess of Iron in the Forage A Lesion of the Follicle and of the Fibre of Wool and its (Prof G Gonzelez, J Garcia and E Fernandez), 559
Relations (Structural) Estimation of Linear and Non-Linear (D E Barton and C L Mallows) 1086
Relations (Time), of Humorally Co-ordinated Chromatic Responses Significance of the (Dr A K Kent) 2027
Relationship to Growth-Stage Floral Initiation and its, in Red Clover (*Trifolium pratense* L), (J L Stoddart), 559
Relationship between Industry and Technical Colleges (Liverpool District of the Federation of British Industries Conference on), 1690
Relationship between Larval and Pupal Periods of some Lepidopterous Insects (Dr M A Zaher and Dr Moufied A Moussa), 283
Relationship of *p*H to Aerobic Corrosion Fatigue Life of Steel (Dr Frederick J Radd, L Hugh Crowder and Louis H Wolfe), 2008
Relationship between *p*H and Volatile Fatty Acid and Diversion of Saliva from the Actively Fermenting Rumen of Sheep (V R McManus), 1572
Relationship between Photophosphorylation and the Hill Reaction (Dr H E Davenport) 524
Relationship between Structure and Physical Properties of Materials (Non-Destructive Testing Group of the Institute of Physics and the Société Française de Métallurgie Discussion on), 1688
Relationship between Weight of Internal Fat, 'Fill', and the Herbage Intake of Grazing Cattle (J C Tayler), 2021
Relationship (θ-φ), for a Constrictive Resistance in Thermal Equilibrium Influence of the Thomson Effect on the (Dr W Davies) 975
Relationship (Dose–Response), in Radiation Leukaemia (Dr P Armitage, Dr W M Court Brown and Dr R Doll), 1669 , (Dr D J Mewissen), 1670
Relationships between its Anti-Atherogenic and Endocrine Actions The C_{17}-OH Group of Œstradiol— (Dr Manuel Rene Malinow, Alvaro L Gimeno, Amanda A Pellegrino-Iraldi, Martha A Fernandez-Gimeno, Jorge L Lacuara and Jaime A Moguilevsky), 1720
Relationships in Industry—some Changing Concepts of Management (British Institute of Management and the Ministry of Labour Conference on), 156
Relationships (Different Cell–Virus) Formation of, in Tumour Cells induced by Polyoma (Dr Leo Sachs and Ernest Winocour), 1702
Relationships (Host–Parasite) Evolution of (British Association for the Advancement of Science, Section D (Zoology), Symposium on), 760
Relative Rates of Exchange of Potassium-42 by the Foetal Metanephros and Foetal Liver (Dr J G Bearn and Dr F T C Harris), 1959
Relative Stability of the Halogenoplatinates A Radiochemical Tracer Study of the (A J Poe and M S Vaidya) 1139
Relatively High-Energy Ions Emission of, from Low-Voltage Arcs (E R Harrison), 345
Relativity (Special) A New Experimental Test of (J P Cedarholm and Prof C H Townes), 1350
Relaxation (Vibrational), and Dissociation of Carbon Dioxide behind Shock Waves (Dr I R Hurle and Dr A G Gaydon) 1858
Relaxation Times (Proton Resonance) in Mobile Liquids (Dr J G Powles and D Cutler), 1123
Relaxing Gases Velocity of Sound in (H J Wintle) 2007
Release of Adenosine Triphosphate and Serotonin from Injured Cellular Blood Elements in Extracorporeal Circuits (Dr H S S Sarajas, Dr R Kristoffersson and Dr M H Frick), 1127
Release of Compounds containing Diaminopimelic Acid from *Vibrio metchnikovi* treated with Antibody and Complement (Dr F Shafa and Dr M R J Salton), 1341
Release by Flight Exercise of a Chemotropic Response from Photopositive Domination in a Scolytid Beetle (Prof Kenneth Graham), 283
Release of Histamine from Rat Mast Cells by Blood treated with Dextran (Dr G T Archer), 1151
Release of Non-Esterified Fatty Acids from Adipose Tissue in Normal and Diabetic Rats (Dr J Wendeova and Dr J Pav), 1147
Release of Nucleotides from Yeast Cells (Masataka Higuchi and Prof Teijiro Uemura), 1381
Release and Use of Atomic Energy (Dr T E Allibone) 1613
Reliability and Quality Control in Electronics Sixth National Symposium on, 1362
Relict Fauna of Ennerdale Water—a Problem of Distribution (Dr W Pennington), 1421
Religion of the Ch'iang The Customs and (D C Graham) B A 15
Religion of Man? A, *review* by Dr D J McCracken, 1571
Remains of Swedenborg Blood Grouping of the (Madeleine Smith), 867
Remanent Magnetization (Natural) of Pre-Cambrian Gneiss of Ongul Islands in the Antarctic (T Nagata and Y Shimizu), 1472
Remnants (Conchiolin) in Mother-of-Pearl from Fossil Cephalopoda (Dr Ch Gregoire), 1157
Removal of Luminescence induced by Tritium Low-Temperature Autoradiography for the Detection of Tritium in Tissue, with (P Pellerin, P Fallot, M Laine-Boszormenyi and F Serrel), 1385
Removal of Strontium and Caesium from Milk (Dr B B Migicovsky), 374
Renaissance Anatomy, *review* by Dr A R Hall, 1761
Renal Blood Flow Mechanism of Autoregulation of (Dr Allen M Scher), 1322
Renal or Enzymic Disorder Essential Pentosuria— (Dr R C Bozian and Prof Oscar Touster), 463
Renbourn, Dr E T , and Stockbridge, H C Ergonomics, its Place in Industry (Activities in the Clothing and Stores Experimental Establishment of the Ministry of Supply), B A 21
Rendel, Dr J M Appointed chief of the Division of Animal Genetics of the Commonwealth Scientific and Industrial Research Organization, 1532 , work of, 1532
Renewable Filter (Continually) A Partial Chemical Characterization of Maize Coleoptile Cell Walls prepared with the Aid of a (Prof Aleksander Kivilaan, Teofila C Beaman and Robert S Bandurski), B A 81
Renewal Times of some Squamous Epithelia in the Guinea Pig (H Platt), 1654
Renshaw, A , and others Alkali Ion Determinations by means of Glass Electrodes (Tests on Experimental Electrodes of Aluminosilicate Glasses), 1617
Renton, Dr P H (Stratton Dr F , and) Practical Blood Grouping, *review* by Dr R A Zeitlin, 130
Reorganization of Root Apices after Irradiation (F A L Clowes) 1025
Repair (Tissue) Wound Healing and (edited by W Bradford Patterson), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Repartition des Êtres Vivants Causes de la (Raymond Furon), *review* by Prof Ronald Good, 390
Replenishment (Nitrogen), in the Soil (Dr N R Dhar), 942
Replicas of Workshops, 1534
Replication of Tobacco Mosaic Virus—Kinetics of Virus Protein and Ribonucleic Acid Biosynthesis (Prof Barry Commoner, Dr James A Lippincott and Dr Janey Symington), 1992 , A Re-examination of Theories /Prof Barry Commoner), 1998
Replication (Fibre Surface), by Rolling (J Molgaard), 264, 1478 , (H J Woods), 1478
Reports of the United States Geological Survey Suggestions to Authors of the, fifth edition, *review* by Prof, C F Davidson, 390
Representation (Polynomial), of Thermodynamic Tables (Prof C J Pings), 444
Representative of a New Group of Bacteria *Fasciculus limpidus* nov gen , nov spec , a (Prof E G Pringsheim), 1098
Reproduction Colour, *review* by Dr W S Stiles, 1092
  The Endocrinology of (edited by Prof Joseph Thomas Velardo), *review* by Dr T Mann, 1434
Reproduction of Colour (Dr R W G Hunt), *review* by Dr W S Stiles, 1092
Reproduction in Domestic Animals (edited by H H Cole and P T Cupps), Vol I, *review* by Dr S J Folley, 1091
Reproduction in a Trans-Equatorial Migrant (the Short-tailed Shearwater *Puffinus tenuirostris*) Experimental Demonstration of an Internal Rhythm of (Dr A J Marshall and Dr D L Serventy), 1704
Reproduction (Asexual), in the Enchytraeidae (Olig), (B Christensen), 1159
Reproduction (House Fly) Role of Cholesterol in (Ronald E Monroe), 1513
Reproduction (Human) Essentials of (edited by Prof Joseph Thomas Velardo), *review* by Dr T Mann, 1434
Reproduction Rate of *Paramecium multimicro-nucleatum* Effect of the Potassium Salt of Gibberellic Acid on the Growth and (A A Oravec, N G Strovilas, J L Beal and Arthur Tye), 1405
Reproduction and Fertility Current Research on, *review* by Dr T Mann, 1434
Reproduction and Infertility Proceedings of the Third Symposium on, Colorado State University (edited by F X Gassner, in association with Rue Jensen and H J Hill), *review* by Dr T Mann, 1434
Reproductive Rhythm (Internal), in a Xerophilous Equatorial Bird, *Quelea quelea* Duration of the Regeneration Period of the (H J de S Disney, B Lofts and Dr A J Marshall), 1659
Requirement (An Absolute), for 'Iron Transport Factors' by *Microbacterium lacticum* 8181 (Dr D Hendlin and Dr A L Demain), 1894
Requirements (Chilling), of Peach Seeds Gibberellic Acid and the (the late Prof Margaretha G Mes), 2034
Research Animal, at the Commonwealth Scientific and Industrial Research Organization, 1532
  Biochemical, in India—Golden Jubilee Symposium (Prof P S Sarma), 1367
  British Space, 24
  Building, in Britain, 1023
  European Nuclear Energy, 1278
  Feltmaking, 320
  Fishery (J H S Blaxter) 865
  Fundamental, in Britain, 1
  Future Marine Biological, *review* by Dr J A Allen, 215
  Geochemical, in the United States, *review* by Dr S R Nockolds 1757
  Instructional Film, in Pennsylvania (C Denis Pegge), 866
  Microbiological, 680
  Nuclear, in Australia, 1118
  Pharmaceutical, in the U S S R , *review* by Dr D Train, 1831
  Radio, 1024
  Rubber, 854
  Safety in Mines (Thirty-sixth Annual Report on), 154
  Scientific, in Alberta, 1370
  Scientific, in British Universities, 1958-59 (British Council), 854
  Scientific, in Great Britain, 1897
  Sea Fisheries, in East Africa, 855
  Sex, 1107
  Soviet Pharmaceutical , Vol I, Pharmaceutical Chemistry, Vol 2, Pharmacognosy , Vol 3, Medicinal Chemistry, *review* by Dr D Train, 1831
  Sponsored, in Great Britain, 235
  Thermonuclear (Physical Society Conference on), 1015
  Water Pollution (1958)—the Report of the Water Pollution Research Board with the Report of the Director of the Water Pollution Research Laboratory (Department of Scientific and Industrial Research), 1542

Research, Journal of, of the United States National Bureau of Standards to be published in four separate Sections, 320
Research, Educational, No 3, 153
Research in the Antarctic during 1960 (Sir Vivian Fuchs), 851 , American Programme, 852
Research in Dairying, National Institute for Annual Report for 1958, 770
  Grant of 89,348 dollars from the Population Council, Inc , New York, in support of researches on cervical mucus, with particular reference to the control of fertility, 1362
Research on Driver Behaviour A Simulator for (Prof J H Mathewson), 237
Research on Element 102, Nobelium (P R Fields *et al*), 507
Research in Gas Dynamics, *review* by Prof J H Horlock, 1173
Research for Industry 1958, a Report on Work done by the Industrial Research Associations in the Government Scheme (Department of Scientific and Industrial Research), 211, 238
Research on Leukaemia and allied Diseases (Lady Tata Memorial Trust Awards for), 507
Research on Noise Current (Derwent M A Mercer), 414
Research in Nuclear Science, National Institute for Contracts for work on the 7,000-MeV Proton Synchrotron *Nimrod*, B A 14
Research in Problems of Sex Grants-in-aid for (United States National Academy of Sciences—National Research Council), 1107
Research on Weed Transportation New Zealand, 1361
Research (Agricultural), in Britain, 238
Research (Agricultural) The Use of Radioisotopes in (Ministry of Food and Agriculture of the Government of India, Food and Agriculture Organization of the United Nations, International Atomic Energy Agency and Unesco South East Asia Science Co-operation Office Course on), 1451
Research (Agricultural), in Eire—An Foras Taluntais (The Agricultural Institute), 28
  Appointment of Dr T Walsh as director, 29
  Appointment of Dr L B O'Moore as chief of the Animal Production Division, 29
  Appointment of J J Byrne as chief of the Rural Economy Division, 29
Research (Agricultural), Indian Council of Misc Bulletin No 82, Bovine Stars of India, 941
Research (Agricultural), Indian Council of, and Unesco International Symposium on Algology, 595
Research (Biological) Electronic Apparatus for (P E K Donaldson), *review* by W J Perkins, B A 4
Research (Clinical Metabolic) Enzymic Activities of Human Skeletal Muscle Mitochondria—a Tool in (Dr L Ernster, Dr D Ikkos and Dr R Luft), 1851
Research (Coke), in Great Britain Progress in, 1778
Research (Current), on Reproduction and Fertility, *review* by Dr T Mann, 1434
Research (Fire) The Use of Models in (Committee on Fire Research and the Fire Research Conference of the Division of Engineering and Industrial Research of the United States National Academy of Sciences –National Research Council Symposium on), 772
Research (Fundamental Cancer) Fourteenth Annual Symposium on (Cell Physiology of Neoplasia), (University of Texas Anderson Hospital and Tumour Institute), 1451
Research (High-Altitude) British Contribution to, 1776
Research (Marine) The Need for, *review* by Dr F S Russell, 129
Research (Nuclear), European Organization for (CERN) Present Status, 944
  International Co-operation in the field of High-Energy Accelerators, 1844
  Election of Officers, 1844
Research (Operations) Mathematical Methods of (Thomas L Saaty), *review* by Prof L S Goddard, 1763
  Mathematics and, *review* by Prof L S Goddard, 1763
Research (Pest Control) Advances in (edited by R L Metcalfe), Vol 2, *review* by F C Bawden, 1258
Research (Physics), Brazilian Centre for Appeal by Unesco and the International Atomic Energy Agency for help to reconstruct the Library of the, 769
Research (Pioneer), on the Atom—the Life Story of Frederick Soddy (Muriel Howorth), *review* by Prof Norman Feather, 298
Research (Plant), Boyce Thompson Institute for, and others Fourth International Conference on Plant Growth Regulation, 599
Research (Scientific) Central African, 407
  Development Trends in Australian, 1027
Research (Scientific), and the Philosophy of Science (British Society for the Philosophy of Science Symposium on), 1193
Research (Scientific and Technological), in Britain Organization of, 1255
Research (Space) Prelude to, *review* by D G King-Hele, 663
Research (Space), Canadian Committee on, 24
Research (Underwater) Application of Ultra-Violet Lights to (Richard G Woodbridge, III, and Dr Richard C Woodbridge), 259
Research (Virus) Advances in (edited by Kenneth M Smith and Max A Lauffer), Vol 6, *review* by N W Pirie, 920
Research and Development Reviews of Data on, No 13, Research and Development and Economic Growth (Dr A T Waterman), (United States National Science Foundation), 591
  Reviews of Data on, No 14, Funds for Research and Development Performance in American Industry (United States National Science Foundation), 1022
  Reviews of Data on, No 15, Grants for Private Philanthropic Foundations during 1957 (United States National Science Foundation), 1272
Research and Development at the Heston Laboratories of Atomic Power Constructions, Ltd , 517
Research and Development Charges in Civil Nuclear Power, 406
Research and Development Expenditure (Government), in Britain Control of, 696
Research and Development Performance in American Industry Funds for (United States National Science Foundation, Reviews of Data on Research and Development No 14), 1022
Research and Development (Aeronautical), Advisory Group for (Combustion and Propulsion Panel) Discussion on the Chemistry of Propellants, 778
  Discussion on Basic Problems in Propulsion, 779
Research and Development and Economic Growth (Dr A T Waterman), (United States National Science Foundation, Reviews of Data on Research and Development, No 13), 591
Research and Production Facilities of Ciba (A R L), Ltd New (R F Webb), 601
Research Appointments (Royal Society), 595
Research Association of British Paint, Colour and Varnish Manufacturers Retirement of Dr L A Jordan as founder-director, 852
Research Associations and their Functions, 211, 238
Research Bureau (Building) Establishment of a (New Zealand Master Builders' Federation and the New Zealand Institute of Architects), 235
Research Centre (Regional) of the British Caribbean Soil and Land-Use Surveys, No 1, Parish of St Catherine, Jamaica (K C Vernon) , No 2, The Rupununi Savannas of British Guiana (R F Loxton, G K Rutherford and J Spector) , No 3, St Vincent (J P Watson, J Spector and T A Jones), 27
Research Council of Alberta Thirty-ninth Annual Report (1958), 1370
Research Council, Overseas Establishment of the, B A 14
Research Equipment Exhibit Ninth Annual Instrument Symposium and (United States National Institutes of Health), 26
Research Fellowships (Travelling) Carlsberg–Wellcome (Awards), 683
Research Grants (Australian Atomic Energy Commission), 940
Research Laboratories (New), for the Cambridge Instrument Company, Ltd (Dr M C Marsh), 1364
Research Laboratories (Physics) The Design of—a Symposium of the London and Home Counties Branch of the Institute of Physics (London, 1957), *review* by S Weintroub, 925
Research Laboratory (Regional), Hyderabad Annual Report for 1957-58, 320
Research Reactor *Merlin*, an Industrial (Dr T E Allibone), B A 11
Research Scholarships Junior Postgraduate Agricultural (Agricultural Institute of Ireland Awards), 1612
Research Studentship (Postgraduate) founded by the Phillips Petroleum Co at University College of North Staffordshire, 322
Research Studentship (a second Postgraduate) founded by the United States Rubber Co at University College of North Staffordshire, 322
Research Studentships for postgraduate training in Ecology (Nature Conservancy Awards for 1959), 156
Research Training Scholarship of the Animal Health Trust awarded to W A G Charleston, 771
Researches in Geochemistry (edited by Philip H Abelson), *review* by Dr S R Nockolds, 1757
Reserpine Abolition by Chlorpromazine of the Inhibiting Effect of Iproniazid on the Depletion of Adrenal Catechol Amines induced by (F Camanni, Dr G M Molinatti and M Olivetti), B A 65
  Effects of, on Secretion from the Denervated Adrenal Medulla (L Stjarne and S Schapiro), 2023
Reservoir (Natural), of *Borrelia duttoni* Is the Multimammate Rat a (Dr F Zumpt), 793
Resident British Birds (Educational Productions, Ltd , Filmstrip CX 6208), 1777
Residual Bodies of Seminiferous Tubules of the Rat (B V Kingsley Smith and Dr D Lacy), 249
Resin, 'Dowex-1' Chemical Activities of *E coli* adsorbed on a (Tsutomu Hattori and Choseki Furusaka), 1566
Resin (An Embedding), Miscible with Water for Electron Microscopy (Dr I R Gibbons), 375
Resin and the Isolation of Thrombins Rivanol, (Dr Kent D Miller), 460
Resins Ion Exchange (Robert Kunin), second edition, *review* by D Reichenberg, 1757
Resins, Rubbers Plastics Appointment of Dr Norman G Gaylord as editor, 1108
Resistance of Adult Houseflies to the Insecticide Dieldrin Mechanisms of (F P W Winteringham and A Harrison), 608
Resistance to DDT in the Blue Tick Pyrethrum Resistance conferred by (G B Whitehead) 378
Resistance to Flow in Vascular Beds (Harris S Burry), 453
Resistance of Houseflies to γ-Benzene Hexachloride and Dieldrin (R G Bridges and J T Cox), 1740
Resistance of *Sorghum* to Witchweed (C N Williams), 1511
Resistance (Acquired), to Experimental 'Allergic' Encephalomyelitis Various Types of (G J Svet-Moldavsky, I A Svet-Moldavskaya and L I Raffkina), 1552
Resistance (Haemolytic) Influence of X-Rays on the Activity of Carbonic Anhydrase in Erythrocytes and on their (A Lauwers, J Van Bavinchove and W Dierick), 111
Resistance (Insulin), of Fasted Rats Effect of Whole-body X-Irradiation on the (Dr V Stanković and N Sestan), 1816
Resistance (Pyrethrum), conferred by Resistance to DDT in the Blue Tick (G B Whitehead), 378
Resistance (Restrictive), in Thermal Equilibrium Influence of the Thomson Effect on the θ-φ Relationship for a (Dr W Davies), 975
Resistivity Changes (Electrical), observed in a Semiconducting Diamond after Heat Treatment (R E Mutch and Dr F A Raal), 1857
Resistor (Silicon) Use of the, in the d c Stabilization of Transistor Circuits (J T Zakrzewski and D H Mehrtens), 811
Resistors (*NTC*) Intravascular and Intracardiac Blood Velocity Patterns recorded by means of (Dr W G Zijlstra, J R Brunsting and L B v d Slikke), 991
Resolution of Wide-range Grating Spectrometers (Dr A E Martin) 975
Resolution (High-) Fibre Optics using Sub-Micron Multiple Fibres (Dr N S Kapany), 881
Resolving Time Effects (Polarization and), in Photon Correlation (Dr E Brannen and Prof W Wehlau), 263
Resonance (Electron Paramagnetic), at 4 2°K of γ-Irradiated Polymethyl Methacrylate and Polymethacrylic Acid (Dr Derick W Ovenall), 181
Resonance (Electron Spin) Free Radicals as Studied by (Dr D J E Ingram), *review* by Dr T M Sugden, 1259
  Free Radicals in X-Rayed Seeds of High and Low Water Content, as Measured by (Dr W Klingmuller, Dr G R Lane, M C Saxena and Dr D J E Ingram), 464
Resonance (Electron Spin), and Divalency of some Dithiocarbamates of the Coinage Metals (Cu, Ag, Au), (Tore Vanngard and Stig Åkerstrom), 183

Resonance (Electron Spin) Investigations of *Allium cepa* and *Calliphora vomitoria* (M Edwards, Dr G A Kerkut, K A Munday, Dr D J E Ingram, M C Saxena and K Leach), 1402
Resonance (Proton) Relaxation Times in Mobile Liquids (Dr J G Powles and D Cutler), 1123
Resources (Living), of the Sea (Dr Lionel A Walford), *review* by Dr F S Russell, 129
Resources (Surface-Water) Techniques for Surveying (Prof Ray K Linsley), (World Meteorological Organization, Technical Note No 26), 96, *erratum*, 684
Resources (Water) Effects of Forest Areas on, and the Technique of Lysimetry—Water and Woodlands (Dr L Leyton), 1184 , Lysimeters (F W Green), 1186
  Information on (Report of the Subcommittee of the Central Advisory Water Committee), B A 18
Resources (Water-) and Water-Use Survey (Dr Alice Garnett), 96, *erratum*, 684
Respiration of Rat Oral Tissue Effect of Vitamin D on the (L Zar and Prof J T Irving), 1410
Respiration-deficiency Rate of Appearance of Mutants with, in *Staphylococci* (G F Gause, G V Kochetkova and N A Sorbaeva), 1821
Respiration (Plastron), in the Eggs of *Drosophila* and other Flies (Dr H E Hinton), 280
Respiratory Brewer's Yeast Effect of Oxygen on Endogenous Metabolism of a (V E Chester), 1956
Respiratory Chain in Liver Mitochondria Functional Organization of the (Dr Tokuji Kimura and Dr Thomas P Singer), 791
Respiratory Enzymes Localization and Assay of, in Single Living Cells—Absorbancy Measurements on the *Nebenkern* (Dr Robert P Perry, Dr Bo Thorell, Dr Lennart Åkerman and Prof Britton Chance), 929 , Fluorescence Measurements of Mitochondrial Pyridine Nucleotide in Aerobiosis and Anaerobiosis (Prof Britton Chance and Dr Bo Thorell), 931 , Absorbancy Measurements on Liver and Kidney Cells (Dr Bo Thorell and Prof Britton Chance), 934
Respiratory Grana Cancer and the (Prof Carl C Lindegren), 397
Response of Cholinergically Innervated Sweat Glands to Adrenaline and Noradrenaline (Dr David P C Lloyd), 277
Response to Heat and Moisture Probing Behaviour of *Aedes aegypti* (L) in (L Burgess), 1968
Response of their Litters to Parotid Tumour Virus (Polyoma Virus) Antibody Status of Mice and (Lloyd W Law, Clyde J Dawe, Wallace P Rowe and Janet W Hartley), 1420
Response of *Sequoia sepervirens* (D Don) Endl and *Pseudotsuga menziesii* (Mirb) Franco Seedlings to Temperature (Henry Hellmers and William P Sundahl), 1247
Response of a Single Retinula Cell to Polarized Light (M Kuwabara and K Naka), 455
Response (Avoidance) Effect of a Signal Contingent upon an (Prof J D Keehn and Sanniyah Nakkash), 566
Response (Chemotropic), from Photopositive Domination in a Scolytid Beetle Release by Flight Exercise of a (Prof Kenneth Graham), 283
Response (Dose-) Relationships in Radiation Leukaemia (Dr P Armitage, Dr W M Court Brown and Dr R Doll), 1669 , (Dr D J Mewissen), 1670
Response (Muscular) Effects of Irradiation of Nerve on (A Portela, D Brandes, Prof G H Bourne, Marion Hines, P Stewart and B L Redd iun), 734
Response (Œstrous), by the Ovariectomized Ewe Seasonal Changes in the, to Progesterone and Œstrogen (Prof J I Raeside and M F McDonald), 458
Response (Specific), in the Hippocampus of the Rabbit to Olfactory Stimulation (B G Cragg), 1697
Responses to Localized Distension of the Oesophagus in Decerebrate Sheep (Prof A F Sellers and Dr D A Titchen), 645
Responses (Chromatic) Significance of the Time Relations in Humorally Co-ordinated (Dr A K Kent), 2027
Responses (Growth), to Selenium in Lambs (Dr J W McLean, G G Thomson and J H Claxton), 251
Responses ('On'- and 'Off'-), of the Olfactory Epithelium (Dr S F Takagi and Dr T Shibuya), 60
Responses (Reflex Muscular) Does an Increase in the Tension in a Ligament elicit (Dr Bertil Stener), 1495
Responses (Retinal), of Pink Salmon associated with its Downstream Migration (Dr M A Ali and Prof W S Hoar), 106
Responsibility (Parliamentary), for Science and Technology, 1190
Rest Potentiation of Contractions after, in the Isolated Rat Ventricle Preparation (Dr R L Speirs), 66
Resting and Action Potentials of Reversed Polarity in Frog Nerve Cells (Dr I Tasaki), 1574
Restoration of Cultural Property, International Centre for the Study of the Preservation and Inauguration of the, 504
  Appointment of Dr H J Plenderleith as first director, 504
Restricting Cows to a Clover-free Diet in order to Reduce the Strontium Content of Milk Implications of (Dr David Purves), 1408
Rete Mirabile in the Gas Bladder of *Coregonus lavaretus* (Goran Fahlen), 1001
Retentate, a New Scientific Term (E G Turner and J G Feinberg), 1139
Retention (Mineral Uptake and), in Cotton-Grass (*Eriophorum vaginatum* L), (Gordon T Goodman and Donald F Perkins), 467, *erratum*, 1845
Reticulo-Endothelial System Effect of Sulphonamides on the Phagocytic Activity of the (Prof T Nicol and I Z Sewell), 1241
Retinal Responses of Pink Salmon associated with its Downstream Migration (Dr M A Ali and Prof W S Hoar), 106
Retinine Photochemical Behaviour of (Photochemical and Stereochemical Properties of Carotenoids at Low Temperatures), (Dr Lawrence Jurkowitz), 614
Retinula Cell Response of a Single, to Polarized Light (M Kuwabara and K Naka), 455
Revans, Prof R W Personnel Management and Technological Change (Application of Operational Research to the Understanding of Human Beings), 1615
Reversal by Acetylcholine of the Inhibition by Thyroxine of Oxidative Phosphorylation in Guinea Pig Heart Sarcosomes (Heitor Medina and Metry Bacila), 1066
Reversal of Effects of 2-Substituted Thiadiazoles by Nicotinamide Analogues and Precursors (Dr Irwin H Krakoff, Corrine R Lacon and Dr David A Karnofsky), 1805
Reversal (Form), in Aphids Ants and (Dr Bruce Johnson), 740
Reversals (Possible), of the Earth's Magnetic Field in the Jurassic Period (Dr R W Girdler), 540
Reverse Thermo-Remanent Magnetism Exchange Interaotion as a Cause of (T Nagata and S Uyeda), 890
Reversed Polarity Resting and Action Potentials of, in Frog Nerve Cells (Dr I Tasaki), 1574
Reversion of Nodules formed by the Grain Boundary Reaction in Aluminium–Zinc Alloys (Ryoji Watanabe and Shigeyasu Koda), 977
Reversion of a Tryptophan-requiring Strain of *Escherichia coli* Effect of Purine and Pyrimidine Analogues on (C O Doudney and F L Haas), 114
Reviews of Data on Research and Development No 13, Research and Development and Economic Growth (Dr A T Waterman), (United States National Science Foundation), 591
  No 14, Funds for Research and Development Performance in American Industry (United States National Science Foundation), 1022
  No 15, Grants for Private Philanthropic Foundations during 1957 (United States National Science Foundation), 1272
Revised Classification of the Ludlovian Succession at Ludlow (C H Holland, J D Lawson and V G Walmsley), 1037
Revised Equilibrium Diagram for the System Al_2l_3-SiO_2 (Shiger Aramaki and Prof Rustum Roy), 631
Revision (Taxonomic), of the Spotted Skunks of the Genus *Spilogale* (R G Van Gelder), 1024
Revolution (Darwinian) Darwin and the (Dr Gertrude Himmelfarb), *review* by Sir Gavin de Beer, 385
Revolution (Scientific) The Two Cultures and the (Sir Charles Snow), 295
  The Two Cultures and the (Dr W L Sumner), 411
Reyniers, James A (and 30 other authors) Germfree Vertebrates—Present Status, 1541
Reynolds, G A , and others (C F H Allen, in collaboration with) Six-Membered Heterocyclic Nitrogen Compounds with Three Condensed Rings, *review* by Dr F G Mann, 216
Reynolds Number (Very High) A Spectrum of Turbulence at (H L Grant, A Moilliet and Prof R W Stewart), 808
L-Rhamnulose to L-Fuculose Enzymic Conversion of, in *Escherichia coli* (Laura Frontali and Giorgio Tecce), 1315
Rheological Study (Solid State), of the Mechanism of Paraffin-Detergent Interactions in Aqueous Systems (F J Radd and L H Crowder), 443
Rheology, British Society of Election of Officers for 1959-60, 943
  Meeting in Manchester, 1535
Rheology, British Society of, and the Colloid and Biophysics sub-Committee of the Faraday Society Discussion on Flow Properties of Blood and other Biological Systems, 322, 1539
Rhinoceros The Great Indian (E P Gee), 1986
Rhipicephalus appendiculatus Neumann New Cell Types in the Salivary Glands of the Brown Ear Tick (Dr W M Till), 1078
Rhizobium Gums Occurrence of 4-O-Methyl Glucuronic Acid in (Beverley A Humphrey), 1802
Rhizobium Polysaccharide Effect of, on the Formation of Polygalacturonase in Lucerne and Clover (H Ljunggren and G Fahraeus), 1578
Rhizome of Bracken Effects of Substituted Phenoxy-Compounds and other Translocated Herbicides on the (Dr Elsie Conway and J A Forrest), 1416
Rhodanine Derivatives Mothicidal (Frederick J Allan, G Graham Allan and Claud M'F M'Neil), 1637
Rhoderick, Dr E H Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 858 , work of, 858
Rhodes, E Thermodynamics (Phase Changes in Condensed Systems), 1609
Rhodesia (Southern) *Haematopota insidiatrix* Austen (Diptera, Tabanidae) in (Dr Robert Barrass), 739
Rhodesia and Nyasaland Occurrence of Presumed Glossopteridean Fructifications in (Dr William S Lacey), 1592
Rhys, D W Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Electron Bombardment Floating-zone Melting of Platinum, Ruthenium, Rhodium and Iridium), 691
Rhythm (Internal), of Reproduction in a Trans-Equatorial Migrant (the Short-tailed Shearwater *Puffinus tenuirostris*) Experimental Demonstration of an (Dr A J Marshall and Dr D L Serventy), 1704
Rhythm (Internal Reproductive), in a Xerophilous Equatorial Bird, *Quelea quelea* Duration of the Regeneration Period of the (H J de S Disney, B Lofts and Dr A J Marshall), 1659
Rhythm (Seasonal), in the Presentation of Bone Sarcoma in Man (Dr C H G Price), B A 76
Rhythms (Endogenous), of Body Temperature in Hibernating Bats (Prof Michael Menaker), 1251
Ribe, F L Ionization Phenomena in Gases (Recent Work on *Scylla* and on a Rotating Plasma Containment Device called *Ixion*), 1355
Ribonuclease Action of, on Nerve Axoplasm as Demonstrated by Silver Staining (R K Winkelmann and Robert W Schmit), 553
Ribonucleases of Mouse Tissues and of the Ehrlich Ascites Tumour (K A O Ellem, J S Colter and Jeanne Kuhn), 984
Ribonucleic Acid Chromosomal Synthesis of as shown by Incorporation of Uridine labelled with Tritium (G Pelling), 655
  Inactivation of some Animal Viruses by Hydroxylamine and the Structure of (Dr Richard M Franklin and Dr Eberhard Wecker), 343
Ribonucleic Acid in Solution Secondary Structure of (Dr R A Cox and Dr U Z Littauer), 818
Ribonucleic Acid Biosynthesis Kinetics of Virus Protein and (Replication of Tobacco Mosaic Virus), (Prof Barry Commoner, Dr James A Lippincott and Dr Janey Symington), 1992
Ribonucleic Acid Synthesis in *Staphylococcus aureus* Selective Inhibition of, by Vancomycin (Prof D C Jordan and W E Inniss), 1894
Ribonucleic Acid (Bacterial) Massive Incorporation of 5-Fluorouracil into a (Dr Jack Horowitz and Prof Erwin Chargaff), 1213
Ribonucleic Acid (Infectious), from Mouse Brains infected with Tick-borne Encephalitis Virus (F Sokol, H Libikova and J Zemla), 1581
'Ribonucleic Acid' (Infective) Failure to Recover, from Myxovirus Preparations (G L Ada, Patricia E Lind, Lois Larkin and Sir Macfarlane Burnet), 360

Ribonucleic Acid (Infective), in Pig Kidney Tissue Culture Monolayers Effect of Proflavine on the Formation of the Virus of Foot-and-Mouth Disease and its (F Brown and Doreen L Stewart), B A 74
Ribonucleic Acid (Polio Virus) Infectivity of, for Embryonated Eggs and Unsusceptible Cell Lines (P de Somer, Dr A Prinzie and E Schonne), 652
Ribo-Nucleic Acids (Deoxyribo- or) Comparative Effects of Heat on Chromatography and Ultra-Violet Absorption of (Dr Saul Kit) 36
Ribonucleic Acids (High Molecular Weight), from the Nuclei of Calf Thymus (Dr Ping-yao Cheng), 190
Ribonucleoprotein (Chromium), from Bovine Liver (Dr W E C Wacker and Dr B L Vallee), 1399
Rice, Edward G , and others Effect of Ethylenediamine Tetra-acetate on Vitamin B_{12} Absorption in the Rat, 1948
Rice, Dr Mary E (Shelton, Dr Emma, and) Relation of Invasive Capacity to Passage of Lymphocytic Cells through Cellulose Membrane Filters, 479
Rice's Blue Material Some Experiments on (J W Clarke and G McTurk), 2014
Rice Chemical Nature of a Plant-Virus Inhibitor from (W A Jones, M Jacobson and R P Kahn), 1146
Rice Plant Fixation of Nitrogen by the (S P Chakraborty and S P Sen Gupta), 2033
Rice Plants Quantitative Changes in γ-Aminobutyric Acid induced by Low Temperature in (F Zsoldos), 280
Ricerche Nucleari, Comitato Nazionale per le, and others Symposium on the Biological Effects of Low Doses of Ionizing Radiations, 1111
Rich, Prof Alexander, and others Statement on Biological and Chemical Warfare, 1018
Richardson, Prof E G Fluctuation Phenomena and Stochastic Processes (Propagation of Sound Waves in a Fluid having Random Variations in either Density or Momentum), 512
  International Congress on Acoustics, 1031
  Music and Electronic Computers, *review*, 1754
  Acoustique Musicale *review*, 1902
Richmond, James H , and others (C F H Allen, in collaboration with) Six-Membered Heterocyclic Nitrogen Compounds with Three Condensed Rings, *review* by Dr F G Mann, 216
Richmond, P T , and others Extended Dormancy of Deciduous Woody Plants treated in Autumn with Gibberellic Acid, 69
Richmond, Virginia, and Hartley, Brian S A Two-Dimensional System for the Separation of Amino-Acids and Peptides on Paper, 1869
Richter, Derek (edited by) Schizophrenia—Somatic Aspects, *review* by Prof Martin Roth, 487
Ridd, J H (de la Mare, Dr P B D , and) Aromatic Substitution—Nitration and Halogenation, *review* by Prof M J S Dewar, 925
Riddell, Dr R W , and others Human Precipitins against Common Pathogenic and Non-Pathogenic Fungi, 1328
Riddell Memorial Lecture (Sir Russell Brain), *review* by F I G Rawlins, 218
Ridge, M J Effect of Temperature on the Rate of Setting of Gypsum Plaster, 47
Ridge (Ectodermal) Limb Development in the Absence of (Dr Eugene Bell, Dr John W Saunders, jun , and Dr Edgar Zwilling) 1736
Rieder W , and Schneider, H Ionization Phenomena in Gases (Re-ignition of a c Arcs), 1355
Rigid-Body and Internal Vibrations of Organic Molecules An X-Ray Study of (Dame Kathleen Lonsdale and Dr H Judith Milledge), 1545
Rigid Medium Photolysis of Thionine in—Measurement by Spectrofluorimetry (Dr C A Parker and W T Rees), 1223
Rijnders, Dr G W A Gas Chromatography (Practical Aspects of the Measurement of Retention Volumes), 1199
Riker, A J , and others Oxidative and Phosphorylative Activities of Cytoplasmic Particles from Plant Tissue Cultures, 1491
Riley Dr R Genetics and the Origin of Species, 588
Rinaldi, E , and others An Antimetabolic Action of Vitamin K, 820
Rinderpest-infected Bovine Tissues Heat Inactivation of (Dr G R Scott), 1948
Ritchey, H W Basic Problems in Propulsion (Solid Propellants), 779
Ritchie, Prof A D Studies in the History and Methods of the Sciences, *review* by Prof A V Hill, 4
  Retirement as professor of logic and metaphysics in the University of Edinburgh, 156
Ritchie, J N At the Eleventh Annual Convention of the Canadian Veterinary Medical Association (Present Position of the Veterinary Services in Britain), 696
Ritual in the Ancient Near East Myth and (Prof E O James), *review* by Prof Norman W Porteous, 1972
Rivanol, Resin and the Isolation of Thrombins (Dr Kent D Miller), 450
River Flow in Great Britain (F W H Green), 210
River Pollution (Dr Louis Klein), I, Chemical Analysis, *review* by Prof R Belcher, 1177
River Pollution Sewage Disposal and Trade Waste Treatment (Department of Civil Engineering and the Department of Extra-Mural Studies in the University of Birmingham Course on), 1451
River Purification (F T K Pentelow), 94
Rivers and Man (Dr Robert Brittain), *review* by Dr E H Brown, 1977
Rivier, Prof D At the 139th Annual Meeting of the Swiss Society for Natural Sciences (La Science a la Recherche d'une Conscience), 1454
Rivington, Christopher T Appointed London scientific editor to Blackie and Son, Ltd , 1451
Rizet G , and Marcou D Cytoplasmic Inheritance (Barrage and Senescence in *Podospora*), 1012
Robb J C , and Holden, H W Coal Science (Spectroscopy of Coals—Volatile Products either Volatilized or Liberated by Pyrolysis when Coal was Heated in the Ion Source), 413
Robbins, Audrey, and others Two Anomalies in the Behaviour of the *F*2 Layer of the Ionosphere, 2003
Robbins, Dr William J Expanding Concepts of Plant Growth Regulation, 599
Roberts, Prof Alun Retirement from the chair of agricultural botany in the University College of North Wales, Bangor, 502 , work of, 502
Roberts, Prof A L and Worrall, Dr W E Clay Minerals (Study of a German 'Fireclay Mineral'), 780
Roberts, Prof A L , and others Separation of the *Meta*- and *Para*-Isomers of the Xylenes, Cresols and Toluidines by Gas Solid Chromatography 1796
Roberts, E The County of Anglesey—Soils and Agriculture (Memoirs of the Soil Survey of Great Britain—England and Wales), (Agricultural Research Council), 154
Roberts F F , and Bassett, H G Transistor Convention and Exhibition, 693
Roberts Dr Henry R (Carleton, Dr Frederick J , and) Preliminary Observations on the Fate of Intravenously Administered Lactose Labelled with Carbon-14, 1650
Roberts, Sir James Denby Appointed chairman of the Joint Committee of the Agricultural and Medical Research Councils and the Development Commission on Biological (Non-Medical) Problems of Nuclear Physics, 237
Roberts, Dr J J , and Warwick, Dr G P Metabolic and Chemical Studies of 'Myleran'—Formation of 3-Hydroxytetrahydrothiophene-1,1-dioxide *in vivo*, and Reactions with Thiols *in vitro*, 1288
Roberts, Dr Morton S A Search for Neutral Atomic Hydrogen in Globular Clusters, 1555
Roberts, Dr P H Fluctuation Phenomena and Stochastic Processes (Random Walk on a Sphere), 510
Roberts, R (Barry, T I , and) Effect of Gamma-Radiation on the Synthesis of Methanol over Zinc Oxide, 1061
Roberts, Sir Sydney At the Annual Conference of the Library Association (Reflections on the Roberts' Report), 1455
Robertson, Dr Alan Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 859 , work of, 859
Robertson, Dr Hamish A , and Falconer, Ian R Accumulation of Radioactive Iodine in Thyroid Glands subsequent to Nuclear Weapon Tests and the Accident at Windscale, 1699
Robertson, Sir James J What are our Schools For ? (Presidential Address to Section L (Education) of the British Association for the Advancement of Science), B A 47
Robertson, Prof J Monteath, and others Crystal Structure of L-Serine Phosphate, 1863
Robertson, Dr N F Appointed to the chair of botany in the University of Hull, 853 , work of, 853
Robertson, Dr R N Appointed a full-time member of the Executive of the Commonwealth Scientific and Industrial Research Organization, Australia, 317 , work of, 317
Robertson, Dr R N , and others Oxidation of Krebs Cycle Acids by Apple Tissue, 506
Robins, Dr A B (Butler, Prof J A V , and) Flow Properties of Biological Systems (Simple Viscometric Measurements (using Concentric Cylinders) for the Study of Nucleic Acid Solutions), 1540
Robinson, D W (Fleming, N , and) Recent Studies of Noise Problems (Human Response to Noise—Evaluation of the Loudness of a Complex Sound), 414
Robinson, Elizabeth (Itano, Dr Harvey A , and) Properties and Inheritance of Haemoglobin by Asymmetric Recombination, 1468
Robinson, Dr F A Biological Properties of Phenols of Plant Origin, *review*, 486
Robinson, F D The Nuclear-Powered Ship, *Savannah*, 677
Robinson, Dr J T A Bone Implement from Sterkfontein, 583
Robinson, K R Khami Ruins—Report on Excavations undertaken for the Commission for the Preservation of Natural and Historical Monuments and Relics, Southern Rhodesia, 1947-1955, *review* by R R Inskeep, 1349
Robinson Sir Robert *Obituary* of Sir Ian Heilbron, 768
Robinson Prof R A Appointed to the chair of chemistry in the University of Malaya in Kuala Lumpur, 306 , work of, 306, 405
Robinson, Trevor Polyethylene Absorption Cells for Infra-Red Spectrophotometry, 448
Robson, A E Ionization Phenomena in Gases (Experiments on the Amperian and Retrograde Motion of Arcs in a Magnetic Field inclined to the Plane of the Cathode), 1355
Roček, Dr J Oxidation of Organic Compounds (Oxidation of *n*-Paraffins), 326
Rochester Conference on Semiconductors, *review* by Dr J R Tillman, 1674
Rock Pressure in Mines (E de St Q Isaacson), *review* by J K L Graham, 1349
Rockborn, Prof Gunnar An Attenuated Strain of Canine Distemper Virus in Tissue Culture, 822
Rockefeller Foundation Retirement of Dr Warren Weaver as vice-president for the natural and medical sciences, 23
  Grant of 30,000 dollars for special equipment for the new Division of Tropical Pastures of the Australian Commonwealth Scientific and Industrial Research Organization, 93
  Grant of 100,000 dollars for the Divisions of Plant Industry and of Entomology of the C S I R O , 93
  Grant of 250 000 dollars towards the cost of the radio telescope for the C S I R O Division of Radiophysics, 93
Rockefeller Institute Honorary degree of D Sc conferred on Dr Peyton Rous and on Dr Herbert S Gasser, 26
  Appointment of Dr J S Gillespie as the first Sophie Fricke Royal Society Research Fellow, 595
Rockefeller Institute (Medical Electronics Center) Bibliography on Medical Electronics, 1026
Rocket The Second Russian Space, 406
  The Third Russian Space (Earth Satellite 1959θ) 852
Rocket *Lunik II* (Russian Moon) Observations of the (Dr J G Davies and Prof A C B Lovell), 501 , (Patrick Moore), 502 , (Dr H Percy Wilkins), 502
Rocket Propulsion (British Association for the Advancement of Science, Section B (Chemistry), Discussion on), 1264
Rocket Studies of Emissions caused by Solar Flares (United States National Science Foundation Grant), 406
Rockets Jets and (A Barker, T R F Nonweiler and R Smelt), *review* by D G King-Hele, 1346
Rockets and Satellites Manual on (edited by L V Berkner, in association with Gilman Reid, John Hanessian, Jr , and Leonard Cormier), *review*, 213
Rocks (Cenozoic Volcanic), in New Zealand Palaeomagnetic Studies of (Dr D S Coombs and Dr T Hatherton), 883
Rocks (Lewisian), from North-West Scotland Rubidium-Strontium Ages of (Dr Bruno J Giletti) 1793

Rodd, Dr E H (edited by) Chemistry of Carbon Compounds, Vol 4, Part B, Heterocyclic Compounds, *review* by Dr F G Mann, 1758
Rodda, Dr Harold J *Obituary* of Dr W A Hargreaves, 92
Rodeheaver, J L, and others Mechanism of Immunological Unresponsiveness, 873
Rodger, Alec Ten Years of Ergonomics, B A 20
Roe, Anne, and Simpson, George Gaylord (edited by) Behavior and Evolution, *review* by Dr W H Thorpe, 1762
Roe, Dr E M F Growth Inhibition of Mouse Ascites Tumour Cells by Powdered Tragacanth (Tragacanthae Pulvis, B P), 1891
Roff, W J Awarded a Nature Conservancy Research Studentship for postgraduate training in ecology (botany), 156
Rogers, Dr A W Autoradiography of Tritium-labelled Compounds on Paper Chromatograms, 721
Rogers, F E Modern Network Theory in Electrical Engineering (Place and Teaching of Electrical Network Theory in Universities and Technical Colleges), 1692
Rogers, G E Structure and Chemistry of Proteins (Structural Organization of Keratin), 1276
Rogers, Dr H J Flow Properties of Biological Systems (Hyaluronidase and Hyaluronic Acid), 1540
Rogers, Dr H J, and Perkins, H R Cell-Wall Mucopeptides of *Staphylococcus aureus* and *Micrococcus lysodeikticus*, 520
Rogers, Dr N A J Appointed lecturer in chemistry at the University of Birmingham, 1026, 1362
Rogulski, Jerzy (Angielski, Stefan, and) Significance of Lactose in the Diet in Aminoaciduria caused by Maleic Acid, 276
Role of the Anion in Magnesium Uptake from Foliar Applications of its Salts on Apple (M Allen), 995
Role of Cholesterol in House Fly Reproduction (Ronald E Monroe), 1513
Role of the Co-enzyme in the Stabilization of Glyceraldehyde-3-phosphate Dehydrogenase (P Elodi and G Szabolcsi), 56
Role of a Dagger Nematode (*Xiphinema* sp) in Outbreaks of Plant Diseases caused by Arabis Mosaic Virus (Dr B D Harrison and Dr C H Cadman), 1624
Role of the Glycolytic Enzyme System in the Germination of Spores of *Bacillus coagulans* var *thermoacidurans* (Prof Mikio Amaha and Tomoko Nakahara), 1255
Role of Magnesium in the Insulin-Sensitivity of the Rat Diaphragm *in vitro* (Dr Gangagobinda Bhattacharya), 1401
Role of the Scholar in Society (Dr Henry Allen Moe), 7
Role of Stroma in Haemoglobin Synthesis—Experiments on Duck Red Cells *in vitro* (A Breccia, A L Fantola, E Lazzarini and A Giustina) 1878
Role (Possible), of Glycerol in the Winter-Hardiness of Insects (P Dubach, D Pratt, Prof F Smith and C M Stewart), 288
Role (Possible), of Higher Proprioceptive Centres in the Perception of Visual Space and in the Control of Motor Behaviour (Dr B Gurevitch), 1219
Role (Possible), of Indoleacetic Acid Oxidase in Crown Gall Tumour Induction (Dr Jacques Lipetz), 1076
Rollason, Prof E C The Electric Arc in Welding, 1030
Rolle, Gloria K and others Inhibition of Skeletal Formation in the Chick Embryo following Administration of Tetracycline, 728
Roller Tube Tissue Cultures Use of Transparent Cellular Film for (John A Sharp), 1508
Rolling Fibre Surface Replication by (J Mølgaard), 264, 1478 , (H J Woods), 1478
Rollinson, D H L, and Lomax, G D Paper Electrophoresis of Hippopotamus Haemoglobin, 1653
Rook, Dr J A F, and Wood, Marian Potassium and Lactose in Milk in relation to the Physiology of Milk Secretion, 647
Rooksby, H P Clay Minerals (Work on Iron and Aluminium Oxides), 780
Room Temperature Paper Chromatography of Corticosteroids at (J Tuzson), 1937
Roonwal, Dr M L, and Chhotani, O B New Neotropical Element (*Anoplotermes*) in Indian Termite Fauna, 1967
Roosen J, and others Association of Radio Outbursts with Solar Flares, 805
Root of *Marsdenia erecta* R Br Sugars of the Glycoside of the Root of (Dr T Baytop, Dr M Tanker, Dr N Oner and Dr S Tekman), 1319
Root Apices Reorganization of, after Irradiation (F A L Clowes), 1025
Root Hairs Cell-Wall Formation in (A B Wardrop), 996
Root Knot Nematode (Southern) A Virus Disease of *Meloidogyne incognita incognita*, the (J R Loewenberg, T Sullivan and M L Schsuter), 1896
Rooting Space Pathogenic Factors in the, and the Development of Even-Aged Plantations (W R Day), B A 46
Roots (Excised Tomato) Nitrate Reduction by Aqueous Extracts of (C S Vaidyanathan and Prof H E Street), 531
  A Non-Dialysable Inhibitor of Glutamo-Transferase present in (C S Vaidyanathan and Prof H E Street), 347
Roots (Onion) Nuclear Deoxyribonucleic Acid Content and Endopolyploidy in the Meristem of (D Srinivasachar), B A 80
Roper, Dr J A Cytoplasmic Inheritance (Acriflavine-induced Cytoplasmic Variants of *Aspergillus*), 1012
  Appointed to the new chair of genetics in the University of Sheffield, 1189 , work of, 1189
Rosa arvensis Huds Induction of Parthenocarpy in, with Gibberellic Acid (M V Prosser and G A D Jackson), 108
Rosbaud, Dr P Distribution of Scientific Publications in Under-developed Countries, B A 23
Rose, Dr H E, and Sullivan, R M E Rapid Estimation of the Specific Surface of a Powder, 46
Rose Bengal Labelling of, with Iodine-131 by Radioactive Exchange (J Liebster and O Andrysek), 913
Rose Bengal Labelled with Iodine-131 Paper Chromatographic Separation of Components of (Fausto W Lima and Rômulo R Pieroni), 1065
Rose Hips The Organic Acids in (Dr G A D Jackson and S E Y Barakat), 1953
  Presence in, of Substances Inhibiting the Oxidation of Ascorbic Acid (Dr G A D Jackson and R B Wood), 902
Rosebury, Prof Theodor, and others Statement on Biological and Chemical Warfare, 1018
Rosen, Hyman, and others Chromatographic Fractionation of Rat Tail Tendon Collagen, 1640
Rosen, Dr L Nuclear Forces and the Few-Nucleon Problem (Binding Energies and Elastic Scattering of Light Nuclei at Low Energies), 1114
Rosenbloom, Paul C (Forsythe, George E, and) Numerical Analysis and Partial Differential Equations, *review* by Prof T A A Broadbent, 576
Rosenbluth, M N, and Rostoker, N Ionization Phenomena in Gases (Theoretical Approach to Transport Phenomena), 1356
Rosengren, Elsa (Kahlson, Prof G, and) Prevention of Foetal Development by Enzyme Inhibition, 1238
Rosensweig, N S, and others Growth Patterns in *Neurospora*—A Biological Clock in *Neurospora*, 169
Ross, D B Awarded a Vitamealo Fellowship by the Animal Health Trust, 771
Ross, Dr D M The Sea Anemone (*Calliactis parssitica*) and the Hermit Crab (*Eupagurus bernhardus*), 1161
Ross, Dr I G, and Wells, E J At the Second Australian Spectroscopy Conference (Studies on the Tetrahedral Molecules OsO_4 and RuO_4), 1195
Ross, Dr I G (Freeman, D E, and) At the Second Australian Spectroscopy Conference (Results of a Normal Co-ordinate Analysis of the 33 Planar Vibrations of Naphthalene), 1196
Ross, Dr I G (Hunt, Dr G R, and) At the Second Australian Spectroscopy Conference (Spectra of Aromatic Hydrocarbons—Vibrational Analysis of the 7000 A and 3500 A Absorption Systems of Azulene), 1195
Ross, Dr W C J (the late Sir John Simonsen and) The Terpenes, Vol 5, The Triterpenes and their Derivatives, *review* by Prof A J Birch, 302
Ross Sea An Oceanographic Survey of the (J S Bullivant), 422
Rosse, Lord Museums and Finance, 598
Rossini, Prof F D Thermodynamics (Experimental Thermochemistry), 1608 , (Physical Constants), 1608
Rostoker, N (Rosenbluth, M N, and) Ionization Phenomena in Gases (Theoretical Approach to Transport Phenomena), 1356
Rotating-Sector Method (A Modified), of Measuring Kinetic Chain Lifetimes (Dr W I Bengough, S A McIntosh and R A M Thomson), 266
Rotation of Newfoundland Palaeomagnetism and (Dr P M Du Bois), B A 63
Rotational Friction Coefficients of Models of Tobacco Mosaic Virus and the Size of the Virus Particle (Dr A J Haltner and Dr B H Zimm), 265
Rotatory Power (Optical), of Collagen (Dr R E Burge and R D Hynes), 1562
Rotblat, Prof Joseph, and others Statement on Biological and Chemical Warfare, 1018
Roth, Prof Martin Schizophrenia, *review*, 487
Rothamsted Experimental Station Report for 1958, 781
Rothstein, E L, and others Effects of Deuterium Oxide on the Synthesis of *T5* and *T7* Bacteriophages, 1167
Rothwell, Pamela, and McIlwain, Carl Satellite Observations of Solar Cosmic Rays, 138
Roucek, Joseph S (edited by) The Challenge of Science Education, *review* by Dr W L Sumner, 923
Roucek, Joseph S (edited by Howard Boone Jacobson and) Automation and Society, *review* by R Brightman, 1438
Rough, Frank A, and Bauer, Arthur A Constitutional Diagrams of Uranium and Thorium Alloys, *review* by Dr D E R Hughes, 925
Roughage Experimental Production of Magnesium Deficiency in Lambs on a Diet of (Dr D M McAleese and Dr R M Forbes), 2025
Roughton, F J W Fast Chemical Reactions in Solution (Fast-Reaction Methods, with particular reference to the Reactions of Haemoglobin), 1453
Round, M C (Froyd, G, and) Infection of Cattle with *Cysticercus bovis* by the Injection of Onchospheres, 1510
Rous, Dr Peyton Honorary degree of D Sc of the Rockefeller Institute conferred on, 26
Rous I Sarcoma Metastases Inhibition of, by a Copper-Catalyst Blocking Agent (Dr B M Jones), 1963
Rouse, W, and others Fusion Frequency and Light Quantity, 1873
Routine Fractionation The Behaviour of Haptoglobin during (Marion Steinbach and L Pejaudier), 362
Routine Methods for Determining Quality in Merino Wool (P L le Roux), 917
Rowatt, E (edited by S T Cowan and) The Strategy of Chemotherapy—Eighth Symposium of the Society for General Microbiology, 1958, *review* by Prof H Berry, 133
Rowe, J A (De Witt, Dr C W, and) *N*,O-Diacetylneuraminic Acid and *N*-Acetylneuraminic Acid in *Escherichia coli*, 381
Rowe, Wallace P, and others Antibody Status of Mice and Response of their Litters to Parotid Tumour Virus (Polyoma Virus), 1420
Rowett Research Institute, Bucksburn Collected Papers, Vol, 15, 410
Rowley, Prof D (Jenkin, Dr C R, and) Opsonins as Determinants of Survival in Intraperitoneal Infections of Mice, 474
Rowlinson, Dr J S Thermodynamics (Phase Changes in Condensed Systems), 1609
  Liquids and Liquid Mixtures, *review* by Prof H S Longuet-Higgins, 1901
Rowlinson, Dr J S, and others Developments in Thermodynamics, 1606
Rowson, L E A (Moore, N W, and) Maintenance of Pregnancy in Ovariectomized Ewes by means of Progesterone, 1410
Roy, Dr J K, and others 8-Hydroxyquinaldic Acid the Red Fluorescent Substance in the Urine of Pyridoxine-deficient Rats, 1573
Roy, Prof Rustum (Aramaki, Shiger, and) Revised Equilibrium Diagram for the System Al_2O_3-SiO_2, 631
Royal Aeronautical Society Formation of an Agricultural Aviation Group, 25
  Discussion on the Structural Effects of Kinetic Heating, 30
  Prize of £5,000 offered by Henry Kremer for the first successful flight of a Man-powered Aircraft, 1534
Royal Agricultural Society of England Medal for research work of benefit to Agriculture, 1450
Royal Aircraft Establishment Appointment of Prof M J Lighthill as director, 151
  Promotion of P A Hufton to Chief Scientific Officer and appointment as head of the Aerodynamics Department, 233
Royal Astronomical Society *Geophysical Journal*, Vol 2, No 1, 504
Royal Australian Chemical Institute Election of C E C Nicholls as president, 1106

Royal Botanic Gardens, Kew (Dr W B Turrill), *review* by Dr Richard A Howard, 1345
Royal Cancer Hospital, London Extension to the Chester Beatty Research Institute, B A 15
Royal College of Science and Technology, Glasgow Retirement of Sir David Anderson as director, 151
  Appointment of Dr S C Curran as director, 152
  Retirement of Prof F S Spring from the chair of chemistry, 233
  Appointment of Dr P L Pauson to the chair of chemistry, 233
Royal Commission for the Exhibition of 1851 Awards of Studentships and Scholarships, 409
Royal Electrical and Mechanical Engineers (adapted to British and Commonwealth Usage by a special Electronics Training Investigation Team of the) Basic Electricity—a Course of Training developed for the United States Navy by Van Valkenburgh, Nooger and Neville, Inc, *review* by G R Noakes, 133
Royal Institute of Chemistry Meldola Medal for 1960, 1192
  Index of Chemistry Films, *review*, 1902
  Monographs for Teachers, No 1, Principles of Electrolysis (Prof C W Davies), *review* by Dr V Gold, 1902, No 2, Principles of Oxidation and Reduction (Dr A G Sharpe), *review* by Dr V Gold, 1902
Royal Institution Christmas Lectures (Dr T E Allibone), 1613
Royal Medals for 1959 of the Royal Society awarded to Prof R E Peierls and Prof P B Medawar, 1360, 1833
Royal Meteorological Society Election of Officers for 1959-60, 1108
Royal Photographic Society (Scientific and Technical Group) Symposium on Photography in the International Geophysical Year, 1032
Royal Society of Edinburgh To microfilm the David Hume manuscripts, 95
  Election of Officers for 1959-60, 1192
Royal Society of London Appointment of Sir Lawrence Bragg as Rutherford Memorial Lecturer for 1960, 26
  Appointment of D J Tritton as Rutherford Scholar for 1959, 26
  Awards by the Paul Instrument Fund Committee, 507
  Appointment of Dr J S Gillespie as the first Sophie Fricke Royal Society Research Fellow in the Rockefeller Institute, 595
  Locke Research Fellowship awarded to Dr B G Cragg, 595
  Stothert Research Fellowships awarded to W D Butt, R A Webster and to J A Hunt, 595
  Some International Geophysical Year Achievements, 604
  Appointment of Dr Ainsley Iggo to a Locke Research Fellowship, 772
  Copley Medal awarded to Sir Macfarlane Burnet, 1189, 1833
  Davy Medal awarded to Prof R B Woodward, 1189, 1834
  Hughes Medal awarded to Dr A B Pippard, 1189, 1834
  Royal Medals awarded to Prof R E Peierls and Prof P B Medawar, 1360, 1833
  Election of Officers, 1610
  Notes and Records, Vol 14, No 1, Darwin Centenary Issue, 1776
  Anniversary Address, The Internal and the External Worlds (Sir Cyril Hinshelwood), 1834
Royal Society of New Zealand T K Sidey (Summertime) Award awarded to Dr J H Piddinggon, B A 16
Royal Society of South Africa (Cape Council of the South African Association for the Advancement of Science and the) Second Science Exhibition, 952
Royal Society of South Australia Verco Medal awarded to Dr C G Stephens, 1611
Royal Society of Victoria Symposium on the Evolution of Living Species, 156
Royal Statistical Society Election of Sir Hugh Beaver as president, 26
Roycroft, J D Appointed to a research fellowship in solid state physics in the University of Glasgow, 1815
Ruanda-Urundi Carte del Sols et de la Vegetation du Congo Belge et du—6, Yangambi, Planchette 3, Lilanda, A, Sols, B, Vegetation (Notice explicative par P Gilson, P Jongen, A Van Wambeke et L Liben), (Institut National pour l'Étude Agronomique du Congo Belge), 27
Rubalcava, Dr H E (Carroll, Dr P K, and) Near Infra-Red System of Nitrogen, 119
Rubber Estimation of Chain Fracture and Cross-Linking of, by High-Energy Radiation (P Hayden), 1865
Rubber Industry, Institute of the Conference on Industrial Technical Organization, 322
  Annual Report on the Progress of Rubber Technology (edited by Dr T J Drakeley), 854
Rubber Manufacturers (British), Research Association of Publication of a translation of the Soviet journal *Kauchuk i Rezina* under the title *Soviet Rubber Technology*, 505
Rubber Research, 854
Rubber Technology Annual Report on the Progress of (edited by Dr T J Drakeley), (Institution of the Rubber Industry), 854
Rubber Technology, Soviet Title of an English translation of *Kauchuk i Rezina*, to be published by the Research Association of British Rubber Manufacturers, 505
Rubi of Great Britain and Ireland Handbook of the (the late W C R Watson), *review* by R D Meikle, 489
Rubidium-Strontium Ages of Lewisian Rocks from North-West Scotland (Dr Bruno J Giletti), 1793
Rubin, Dr B A Tolerance to Skin Homografts of Adult Mice after Parabiosis, 205
Rubin, M L, and others Growth Patterns in *Neurospora*—A Biological Block in *Neurospora*, 169
Rudall, K M (Parker, K D, and) Biological Fibres, B A 26
Ruddlesden, Dr S N Special Ceramics (Dependence of Macroscopic Properties on Crystal Structure), 1115
Ruddock, R, and Wilson, Dr A After Work—Leisure and Learning in Two Towns, 1034
Rudebeck, Gustaf, and others (edited by) South African Animal Life—Results of the Lund University Expedition in 1950-1951, Vol 5, *review*, 133
Rudnick, Dorothea (edited by) Cytodifferentiation (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
  Embryonic Nutrition (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Ruins Khami—Report on Excavations undertaken for the Commission for the Preservation of Natural and Historical Monuments and Relics, Southern Rhodesia, 1947-1955 (K R Robinson), *review* by R R Inskeep, 1349
Rumen Metabolism in the (E F Annison and D Lewis), *review* by Dr D P Cuthbertson, 839
Rumen (Actively Fermenting), of Sheep Relationship between *p*H and Volatile Fatty Acid and Diversion of Saliva from the (W R McManus), 1572
Rumen Contents The Anterior Pituitary-like Activity of (Dr F A Soliman), 1723
Rumen Protozoa Hydrogenation of Lipids by (Dr D E Wright), 875
  Isolation of 2-Aminoethane Phosphonic Acid from (Masaaki Horiguchi and Makoto Kandatsu), 901
Ruminants and Non-Ruminants Trans-Unsaturated Acids in the Depot Fats of (L Hartman and Dr F B Shorland), 2024
Rumination, *review* by Dr D P Cuthbertson, 839
Runners in the Strawberry Effect of Gibberellic Acid on the Initiation of Flowers and (P A Thompson and C G Guttridge) B A 72
Rural England, Council for the Preservation of (Sheffield and Peak District Branch) Twenty-eighth Annual Report (1959), 408
Rural Life (English), Museum of Report for 1958, 505
Rushbridge, M G Thermonuclear Research, 1015
Russell, Bertrand—Philosopher, *review* by Prof R B Braithwaite, 749
Russell, Bertrand My Philosophical Development, *review* by Prof R B Braithwaite, 749
  Wisdom of the West (edited by Paul Foulkes), *review* by Gerd Buchdahl, 1829
Russell, Dr F S The Need for Marine Research, *review*, 129
  A Viviparous Deep-Sea Jellyfish, 1527
Russell, Sir John Election as a member of the Polish Academy of Sciences, 95
Russell, L B Biological Effects of Low Doses of Ionizing Radiations (Chronic Irradiation less effective than an Acute Dose in bringing about Still-births and Neonatal Deaths), 113
Russell, Dr R L Appointed to the chair of electrical engineering in King's College, Newcastle-upon-Tyne 404, work of, 404
Russell, Dr R Scott Availability of Plant Nutrients (Nutrient Absorption by Roots), 160
Russell, Wm C Appointed to a research fellowship in virology (first Lock fellowship) in the University of Galsgow, 1915
Russell, W L Biological Effects of Low Doses of Ionizing Radiations (Genetic Effects of Ionizing Radiation on Mice), 1113
Russell, Dr W M S, and Burch, R L The Principles of Humane Experimental Technique, *review* by Prof M Weatherall, 1675
Russian Journal of Inorganic Chemistry (A translation of the Russian *Zhurnal Neorganicheskoi Khimii*, published by the Chemical Society,) 319
Russian Moon Rocket *Lunik II* Observations of the (Dr J G Davies and Prof A C B Lovell), 501, (Patrick Moore), 502, (Dr H Percy Wilkins), 502
Russian Space Rocket The Second, 406
  The Third (Earth Satellite 1959 θ), 852
Russian View of Space Flight *review* by D G King-Hele, 836
Rust (Wheat Stem), Race 15*B* Biosynthesis of some Amino-Acids from Sucrose by Germinating Uredospores of (B Kasting, A J McGinnis and W C Broadfoot), 1943
Ruston, G (Parker, W G, and) Chemistry of Propellants (Merits of Utilizing High-Energy Propellants), 778
Rutgers, Prof A J Ratio of Nucleon Mass and Electron Mass, 894
Rutgers, G A W, and others Ionization Phenomena in Gases (Post-arc Behaviour of two Practical Circuit Breakers), 1355
Rutherford, G K, and others Soil and Land-Use Surveys of the Regional Research Centre of the British Caribbean, No 2, The Rupununi Savannas of British Guiana, 27
Rutherford High Energy Laboratory The Proton Linear Accelerator, 94
  The *Nimrod* 7,000-MeV Proton Synchrotron, B A 14
Rutherford Memorial Appointments (Royal Society), 26
Rutin Microbial Degradation of (Dr S Hattori and I Noguchi), 1145
Rutledge, Dr P V (Marshall, Dr J G, and) A Higher Hydrogen Peroxide, H_2O_4?, 2013
Rutscher, A Ionization Phenomena in Gases (Striations in the Positive Column of Glow Discharges), 1355
Ryan, W D Appointed lecturer in light electrical engineering at Queen's University, Belfast, 322
Rydzewski, Dr J R Appointed lecturer in civil engineering at the University of Southampton, 595

SAATY, Thomas L Mathematical Methods of Operations Research, *review* by Prof L S Goddard, 1763
Saba, N Biosynthesis and Secretion of Adrenocortical Steroids (Mode of Action of Corticotrophin from the Biochemical Point of View), 417
Sac-like Structures (Embryo), in the Microsporangia of *Leptomeria billardierii* R Br Occurrence of (Dr Manasi Ram), 914
Saccharomyces cerevisiae Nucleotide–Peptide Compounds of (G Harris and J W Davies), 788
Saccone, C, and others An Antimetabolic Action of Vitamin K, 820
Sachs, K, and others Identification of the High-Temperature Constituent in Mild Steel Surface-Hardened by Carbo-Nitriding, 1312
Sachs, Dr Leo, and Winocour, Ernest Formation of Different Cell–Virus Relationships in Tumour Cells induced by Polyoma, 1702
Sacks, T G (Coetzee, Prof J N, and) Lysogeny in the Genus *Proteus*, 1340
Saddington, K, and Templeton, W L Disposal of Radioactive Waste, *review*, 301
Sadhu, Prof D P (Ray, Amal, and) Carbohydrate Metabolism in Hypervitaminosis A, 1323
Sadler, D H Promoted to Deputy Chief Scientific Officer in the Scientific Civil Service, 858, work of 858
Saelen, O Polar Front Survey—Hydrography (Greenland and Norwegian Seas), 1181, (Norwegian Work carried out in collaboration with R R S *Discovery II* west of Portugal), 1182
Safety in Mines Research Establishment Thirty-sixth Annual Report (1957), (Ministry of Power), 154

Safety (Radiation), and Health Physics (J W Lucas), 329
Sager, Dr R Cytoplasmic Inheritance (Extrachromosomal Heredity in Green Plants), 1012
Sagisaka, S, and Shimura, Prof K Enzymic Reduction of α-Aminoadipic Acid by Yeast Enzyme, 1709
Sahasrabudhe, Dr M B, and others Inhibition of Tumour Growth with 2 5-Dicarbethoxy-3 4-Dihydroxy-Thiophene, 201
Sahni (Birbal) Medal for 1958 of the Indian Botanical Society awarded to Prof P Maheshwari, 95
Saikia, A, and others Chromatographic Identification of the Antilipaemic X Factor of the Unsaponifiable Fraction of Crude Vegetable Oils, 1635
Saito, Saburo (Seno, Tamikazu, and) A Chimaeric Duck with the Head of a Chick, B A 78
Saito, Tsuneyuki, and others Changes in Purine Nucleotides of Red Lateral Muscle of Rainbow Trout, 1415
Sakaguchi Reaction The Coloured Product of the (Kshirod R Bhattacharya), 53
Salaries Analysis Clerical (1958), (Office Management Association), 698
Salem, Dr H (Bilbey, Prof D L J, and) Influence of Sulphur Dioxide Inhalation on the Phagocytic Activity of the Macrophage System, 722
  Assessment of the Phagocytic Activity of the Macrophage System, 992
Salicylate and Potassium Fluxes of Rat Diaphragm (Dr J A Hicklin), 2029
Salicylic Acid Conversion of, to Gentisic Acid and *o*-Pyrocatechuic Acid, all Labelled with Carbon-14, in Plants (Dr Ragai K Ibrahim and Prof G H N Towers), 1803
Salinity (Soil) Course in Tunisia (Prof W R van Wijk), 1778
Saliva from the Actively Fermenting Rumen of Sheep Relationship between *p*H and Volatile Fatty Acid and Diversion of (W R McManus), 1572
Saliva-Serum Ratios of Deuterium Oxide after Administration of Heavy Water (Nan Taggart and Dr F E Hytten), 457
Salivary Glands of the Brown Ear Tick, *Rhipicephalus appendiculatus* Neumann New Cell Types in the (Dr W M Till), 1078
Sallman, Prof Bennett, and others Staphylocoagulase Inhibition by Pooled Human Gamma-Globulin, 1665
Salmon, Dr A J Directory of Nuclear Reactors, *review*, 1438
Salmon, Prof E S *Obituary* by Dr H H Glasscock, 1188
Salmon, Dr J E, and Hale, D K Ion Exchange, a Laboratory Manual, *review* by D Reichenberg, 1757
Salmon, L (Peirson, D H, and) Gamma-Radiation from Deposited Fall-Out, 1678
Salmon The (Dr J W Jones), *review* by Dr Arthur E J Went, 577
Salmon (Atlantic) Sodium Regulation in the Blood of Parr and Smolt Stages of the (Prof H J Koch, J C Evans and E Bergstrom), 283
Salmon (Chum) Two Haemoglobins in (K Hashimoto and Prof F Matsuura), 1418
Salmon (Pink) Retinal Responses of, associated with its Downstream Migration (Dr M A Ali and Prof W S Hoar), 106
Salmon (Quinnat) Stomach Contents of Spawning (J S Bullivant), 71
Salmonella Galactose-sensitive Mutants of (Toshio Fukasawa and Hiroshi Nikaido), 1168
Salmonella typhi Mutation in the Type-determining Phages of (E S Anderson), 1822
Salmonella typhimurium Fertility Factor in (T Miyake), 657
Salt, R W Survival of Frozen Fat Body Cells in an Insect, 1426
Salt (A New Crystalline), of Oxytocin (Dr Miklos Bodanszky and Prof Vincent du Vigneaud), 981, *erratum*, 1777
Salt-affected Soils Diagnosis, Improvement and Management of (Unesco Middle East Science Co-operation Office Regional Training Course on), 1778
Salt Desorption from Halloysite (Prof G W Thomas), 1746
Salt (Potassium), of Gibberellic Acid Effect of the, on the Growth and Reproduction Rate of *Paramecium multimicro-nucleatum* (A A Oravec, N G Strovilas, J L Beal and Arthur Tye), 1405
Salter, Dr G R The Electric Arc in Welding, 1031
Saltman, Dr Paul, and others Effects of Auxin and Gibberellic Acid on Growth of *Ulothrix*, 556
Salton, Dr M R J (Shafa, Dr F, and) Release of Compounds containing Diaminopimelic Acid from *Vibrio metchnikovi* treated with Antibody and Complement, 1341
Salts Role of the Anion in Magnesium Uptake from Foliar Applications of its, on Apple (M Allen), 995
Salts (Dipyridyl Quaternary) Redox Properties of some (R F Homer and T E Tomlinson), 2012
Salts (Ferric) Oxidation of Ethyl Alcohol by a Mixture of Hydrogen Peroxide and (Dr Mordechai L Kremer), 720
Salts (Potash) Biological Action of Potassium-40 in Naturally Occurring (Prof E Welte and Kl Mechsner), 1958
Saluretic Sulphonamides An Antimineralocorticoid Action of some (Dr G C Kennedy and Dr J D Crawford), 1492
Salvage, Dr B F Appointed lecturer in electrical engineering at the University of Leeds, 684
Samal, K, and others Propagation of Ultrasonic Waves in Liquids, 352
Samec, Prof M At the ninth International Starch Convention (Bursting and Tear Strength of Paper), 514
Sample (Highly Purified), of the Urinary Gonadotrophin Preparation of a (Roland Bourillon, Rene Got and Rene Marcy), 983
Samples (Antarctic Snow) Oxygen Isotope Variations in (Dr R Gonfiantini and Prof E Picciotto), 1557
Sampling (Blood) Effect of Dietary Fat and Extent of, on the Level of Plasma Cholesterol in the Rat (I Coleman and J M R Beveridge), 1039
Sampson, D R, and MacArthur, M Floral Abnormalities in Broccoli, 682
Samson, C A Effect of Atomic Tests on Radio Noise, 538
Samuels, L E The Nature of Polished Metal Surfaces, 1280
Sanders, Dr H G Balance in British Farming (Presidential Address to Section M (Agriculture) of the British Association for the Advancement of Science), B A 48
Sanders, J, and others Isotopic Composition of Boron, 185
Sandford, B P, and Heiser, P Colour Photography of the Aurora, 540
Sandground, Dr J Evolution of Host–Parasite Relationships (Onchocerciasis in Guatemala and in the Gold Coast), 763
Sandison, A Influence of Site and Season on Agricultural Variety Trials, 834
Sandwich Course in Executive Development (Sheffield College of Technology), 235
Sandwich Courses for Teaching Technologists and Technicians (Dr P F R Venables), *review*, 1437
Sandwith, N Y Cacti, *review*, 1010
Sanerkin, N G Appointed lecturer in pathology at the University of Bristol, 322
Sangiorgi, G, and others Increase by Chlorothiazide of the Paralysing Activity of *d*-Tubocurarine Chloride, 1235
Sanguisorba (Genus) Cytology of the (Kai Larsen), 743
Sansome, Dr Eva Pachytene in *Puccinia kraussiana* Cooke, on *Smilax kraussiana*, 1820
Sansome, Prof F W Appointed professor of botany in the University College of Ghana, Achimota, 26
Sanyal, R K, and others Insulin and Hypersensitivity, 2020
Sap (Sieve-Tube) Composition of (A J Peel and Dr P E Weatherley), 1955
Sarabhai, Dr V, and Palmeira, R North–South Anisotropy and Anticipatory Increase of Intensity associated with the Cosmic-Ray Storm of February 11, 1958, 1204
Saraga, Dr W Modern Network Theory in Electrical Engineering (Analysis and Synthesis of Reactance Networks in terms of the 'one-points' of various Functions), 1692
Sarajas, Dr H S S, and others Release of Adenosine Triphosphate and Serotonin from Injured Cellular Blood Elements in Extracorporeal Circuits 1127
Sarcoma (Bone), in Man A Seasonal Rhythm in the Presentation of (Dr C H G Price), B A 76
Sarcoma (Crocker), and Ehrlich Ascites Carcinoma Effect of Chlorpromazine on (Prof M Chorazy), 200
Sarcoma Metastases (Rous I) Inhibition of, by a Copper-Catalyst Blocking Agent (Dr B M Jones), 1963
Sarcoma and Hepatoma (Rat) An Attempt to produce Malignant Change with Deoxyribonucleic Acid from (Dr J G Bearn), 824
Sarcosomes (Guinea Pig Heart) Reversal by Acetylcholine of the Inhibition by Thryoxine of Oxidative Phosphorylation in (Heitor Medina and Mery Bacila), 1066
Sarcosomes (Heart) Corticosterone Inhibition of Pyridine Nucleotide Oxidase from (P K Jensen), 451
Sardine (Pacific), *Sardinops caerulea* (Girard) Behavior and Reactions of the, under the Influence of White and Colored Lights and Darkness (Dr A S Loukashkin and Dr N Grant), 865
Sardinops caerulea (Girard) Behavior and Reactions of the Pacific Sardine, under the Influence of White and Colored Lights and Darkness (Dr A S Loukashkin and Dr N Grant), 865
Sargent, Dr R Vapour–Liquid Equilibrium Treatise, *review*, 837
Sarma, Prof P S Biochemical Research in India—Golden Jubilee Symposium, 1367
Sarma, Prof P S and others Effect of Sulphanilamide on Citric Acid Production by *Aspergillus niger*, 461
Sartorius Muscle (Frog) Changes in Fluorescence in a, following a Twitch (Prof Britton Chance and Frans Jobsis), 195
Sasaki, I, and others Proof of the Formation of Enzyme-Substrate Complex by 'Crossing-Paper Electrophoresis', 638
Sass, Martin D, and others Enzymes and Radioactivity in Erythrocytes of Different Ages, 643
Sasso, Wilson da Silva (de Castro, Mylceo Marques, and) Sex Chromatin ('Chromoleme') in the Purkinje Nerve Cells of some Mammals, 293
Sastry, L V S, and Ramakrishnan, T Biochemical Research in India (New Type of Enzymatic Transamination Reaction in which Glyoxylate Transaminates with a number of Amino-Acids to produce Glycine), 1368
Satellite 1958δ_2 (*Sputnik III*) The Continued Progress of (B R May and D E Smith), 765
  Signals from (B G Pressey), 261
Satellite 1958δ over Australia Radiation Observations with (Dr A J Herz, Dr K W Ogilvie, J Olley and R B White), 391
Satellite 1959θ Earth (The Third Russian Space Rocket), 852
Satellite Observations of Solar Cosmic Rays (Pamela Rothwell and Carl McIlwain), 138
Satellite Orbit Observations Air Density in the Upper Atmosphere from (Dr G V Groves), 178
Satellite Orbits Density of the Upper Atmosphere from Analysis of—Further Results (D G King-Hele), 1267
Satellites Manual on Rockets and (edited by L V Berkner, in association with Gilman Reid, John Hanessian, Jr, and Leonard Cormier), *review*, 213
Sato, Dr Ryoitiro Structure of Precipitated Cadmium Sulphide as studied by Single-Crystal Electron Diffraction Pattern, 2005
Saturation (Current-) Plasma Heating by (K A George), 1791
Satyanarayana, G, and Rangaswami, Dr G Effect of Indole Acetic Acid and α-Naphthalene Acetic Acid on the Growth, Flowering and Fruit Set in Sweet Potato, B A 73
Saunders, J B de C M (Steuer, Robert O, and) Ancient Egyptian and Cnidian Medicine, *review* by Dr Douglas Guthrie, 662
Saunders, jun, Dr John W, and others Limb Development in the Absence of Ectodermal Ridge, 1736
Saunders, W M H Aluminium extracted by Neutral Citrate-Dithionite Reagent, 2037
Savage, J H At the Second Australian Spectroscopy Conference (A Photographic Spectrograph in Routine Control in the Steel Industry), 1197
Savage, Robert H Wear Observations through Interfacial Micro-Windows, 45
Savannah, the First Atomic Merchant Ship, B A 15
  The Nuclear-Powered Ship (F D Robinson), 677
Sawyer, Wilbur H, and others Active Principles of the Neurohypophysis of Cold-blooded Vertebrates—Pharmocological Evidence for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates, 1464
Saxen, Dr Erkki (Penttinen, Dr Kari, and) Growth-Controlling Action of Human Serum in Cell Culture, 1570
Saxena, M C Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Saxena, M C, and others Free Radicals in X-Rayed Seeds of High and Low Water Content, as Measured by Electron Spin Resonance, 464
  Electron Spin Resonance Investigations of *Allium cepa* and *Calliphora vomitoria* 1402

Scale of Time An Absolute (Sir John Carroll), 260
Scale (Time-) The Geological (Prof J Laurence Kulp, James C Cobb, Leon E Long and Donald S Miller), B A 62 , (Prof C F Davidson), 1310, 1473
Scarselli, Dr V Some Improvements in Colorimetric Determination of Elastin, 1563
Scatter Mechanisms in Tropospheric Radio Propagation Inadequacy of (P C M de Belatini), 1558
Scenery (Cornish) Preservation of, 1776
Scepticism Science and, *review* by Prof C K Grant, 1975
Schaefer, Dr H Polar Front Survey (Biology—Distribution of Amino-Acids in Redfish, *Sebastes*), 1183
Schafer, Prof K Thermodynamics, 1606
Schafer, Prof K , and others Developments in Thermodynamics, 1606
Schafroth, Dr M R *Obituary* by Dr S T Butler, 403
Schallreuter, W Ionization Phenomena in Gases (Striations in the Positive Column of Glow Discharges), 1355
Schapiro, S (Stjärne, L , and) Effects of Reserpine on Secretion from the Denervated Adrenal Medulla, 2023
Schardin, H Atomic Mechanisms of Fracture (Measurement of Crack Velocities in Glasses of various Compositions), 324
Schatsky, Academician N S Elected to foreign membership of the Geological Society of London, 1360
Schechtman, A M , and others Tumour Specificity and Immunological Suppression, 563
Scheiber, Eszter, and others A New Trichothecin-like Antifungal Antibiotic, 908
Scher, Dr Allen M Mechanism of Autoregulation of Renal Blood Flow, 1322
Scheuer, Prof Paul J , and Horigan, Thomas J A New Carbonyl Compound from *Piper methysticum* Forst , 979
Schiff Reagents (Porter–Silber and) Use of, as Spot Tests for Steroids applied on Paper and their Application to the Study of Rat Adrenal Lipids (Dr Marion K Birmingham) B A 67
Schiff-Type Reagents (Fluorescent), for Cytochemical Detection of Polyaldehyde Moeties in Sections and Smears (Prof Frederick H Kasten, Vivian Burton and Peggy Glover), 1797
Schilder, Prof Dr F A and Schilder, Dr Maria Die Bänderschnecken, eine Studie zur Evolution der Tiere, *review* by Dr A J Cain, 390
Schilder, Dr Maria (Schilder, Prof Dr F A , und) Die Bänderschnecken, eine Studie zur Evolution der Tiere, *review* by Dr A J Cain, 390
Schindler, Dr O , and others Isolation of 24-Methylene-cholesterol from Honey Bees (*Apis mellifica* L), 732
Schistocerca gregaria Effect of Insecticides on the Bodies of Nissl and Neurofibillae of the Locust (Dr Tohamy A Moussa and M Banhawy), 915
Schizophrenia, *review* by Prof Martin Roth, 487
  Chronic (Dr Thomas Freeman, John L Cameron and Andrew McGhie), *review* by Prof Martin Roth, 487
  A New Approach to (Dr Julius I Steinfeld), *review* by Prof Martin Roth, 487
  Somatic Aspects (edited by Derek Richter), *review* by Prof Martin Roth, 487
Schlicht, I , and others Estimation of Small Percentages of Foetal Haemoglobin, 1877
Schlumbohm, H Ionization Phenomena in Gases (Primary Ionization Coefficient obtained from Measurements of Avalanche Statistics), 1354
Schmidt, Prof W J , und Keil, Dr A Die gesunden und die erkrankten Zahngewebe des Menschen und der Wirbeltiere im Polarisationsmikroscop, *review* by Prof A I Darling, 218
Schmit, Robert W (Winkelmann, R L , and) Action of Ribonuclease on Nerve Axoplasm as Demonstrated by Silver Staining, 553
Schneider, A Thermodynamics (Experimental Thermochemistry), 1607
Schneider, H (Rieder, W , and) Ionization Phenomena in Gases (Reignition of a c Arcs), 1355
Schneiderman, Dr Howard A (Gilbert, Dr Lawrence I , and) Prothoracic Gland Stimulation by Juvenile Hormone Extracts of Insects, 171
Schnitzer, J (Wright, J R , and) Oxygen-containing Functional Groups in the Organic Matter of a Podzol Soil, 1462
Schoch, Dr T J At the ninth International Starch Convention (Modern Methods of Starch Chemistry), 513
Schoenberg, C Comparative Studies in Ultrastructure (Electron Micrographs of the Smooth Muscles of Vertebrates), 1446
Schoenus nigricans L Occurrence of, on Ombrogenous Peats (D J Bellamy), 1590
Schofield, Dr R Availability of Plant Nutrients (Stages in Transfer of Nutrients from the Soil Surfaces), 159
Schofield, Dr R (Thomason, D , and) Heparin and Cellular Calcium, 1712
Scholar in Society Role of the (Dr Henry Allen Moe), 7
Scholarly Tradition Nuclear Technology and the, *review* by Dr J Walker, 1973
Scholarship (Research Training), of the Animal Health Trust awarded to W A G Charleston, 771
Scholarships for 1959-60 (National Research Council of Canada), 26
Scholarships Junior Postgraduate Agricultural Research (Agricultural Institute of Ireland Awards) 1612
  Perkin Centenary Trust (Awards), 237
  Studentships and (Royal Commission for the Exhibition of 1851 Awards), 409
  Trevelyan (Second awards of), 1845
Scholarships in Colour Photography Kodak, 1915
Schon, Dr Harald Sterol-Balance Experiments in Humans, 1872
Schonne, E , and others Infectivity of Polio Virus Ribonucleic Acid for Embryonated Eggs and Unsusceptible Cell Lines, 652
School (The Graduate), in Mathematical Physics at Birmingham (Prof R E Peierls), 96
School (Summer), for Science Teachers (Australian Nuclear Research Foundation), 1108
School Child The Health of the—Fifty Years of the School Health Service (Report of the Chief Medical Officer of the Ministry of Education for 1956 and 1957), 98
School-Feeding Seminar for countries in South and East Asia (Food and Agriculture Organization and the World Health Organization of the United Nations) 420
School Health Service The Health of the School Child—Fifty Years of the (Report of the Chief Medical Officer of the Ministry of Education for 1956 and 1957), 98
School Meals in Asia and the Far East, 420
Schools Filmstrips for, 1777
Schools For What are our (Sir James J Robertson), B A 47
Schools (Secondary Modern) Mathematics in (Mathematical Association Discussion of the Report on) 32
Schou, Jens (Hvidberg, Eigill, and) Subcutaneous Absorption of Urethane in Dehydrated and Fasted Mice, 646
Schraudolf, H , and Reinert, Prof J Interaction of Plant Growth Regulators in Regeneration Processes, 465
Schreiber, Dr V , and Kmentova, Dr V Effects of Methylthiouracil or Thyroidectomy on Activation of Pituitary Acid Phosphatases *in vitro* by Whole Hypothalamic Extract, 728
Schrier, Stanley L , and others Glucose-6-phosphate Dehydrogenase and Human Erythrocytes—Mechanism of Inactivation of Glucose-6-phosphate Dehydrogenase in Human Erythrocytes, 1292
Schubert, Prof Hans Elected a member of the Mathematics Section of the Leopoldina Academy of Natural Sciences, 595
Schulman, Dr J H (edited by Dr J B Birks and) Progress in Dielectrics, Vol 1, *review* by Dr V Daniels, 1175
Schultz, D L Thermonuclear Research (Shock Waves in Gases), 1018
Schulz, G J Ionization Phenomena in Gases (Shape of an Excitation Function from its Onset to 3 eV above Onset), 1354
Schuster, Sir George Creative Leadership in a State Service—a General Survey (Hospitals and the State—Hospital Organization and Administration under the National Health Service, Sixth and Final Research Report), 1087, 1201
Schuster, M L , and others A Virus Disease of *Meloidogyne incognita incognita*, the Southern Root Knot Nematode, 1896
Schwab, G M Thermodynamics (Phase Changes in Condensed Systems), 1609
Schwartz, Albert Variation in Lizards of the *Leiocephalus cubensis* Complex in Cuba and the Isla de Pinos, 1107
Schwartz, Dr Herbert C (Hill, Dr Robert L , and) A Chemical Abnormality in Haemoglobin G, 641
Schwartz, Jacob T (Dunford, Nelson, and) Linear Operators, Part I, General Theory, *review* by Prof L S Goddard, 1763
Schweinfurth, C Orchids of Peru, 409
Science Conceptual Foundations of, *review* by Gerd Buchdahl, 572
  Education for the Age of (Report of the Science Advisory Committee to the President of the United States), 81, 87
  The First Minister for (Rt Hon Viscount Hailsham), 1263
  History and Philosophy of (L W H Hull), *review* by Dr H D Anthony, 131
  How Much (Prof J Jewkes), B A 44
  Liberty in an Age of (Sir Solly Zuckerman), 135
  Orchard, *review* by Prof H W Miles, 487
  Scientific Research and the Philosophy of (British Society for the Philosophy of Science Symposium on), 1193
  The Structure of (Wistar Institute of Anatomy and Biology Symposium on) B A. 6
Science, Australian Academy of New Building of the, B A 10
  Selby Fellowship, 684
Science, British Society for the Philosophy of Fourth Annual Conference, 1193
  Symposium on Scientific Research and the Philosophy of Science, 1193
  Symposium on Biology and Physics, 1193
  Symposium on Classification, Concept-formation and Language, 1193
  Symposium on Knowing and Being, 1193
Science Advisory Committee to the President of the United States Report on Education for the Age of Science, 81, 87
Science Council of Japan Proceedings of the International Symposium on Enzyme Chemistry, Toyko and Kyoto, 1957 (under the auspices of the International Union of Biochemistry), *review* by Dr J B Chappell, 388
Science Museum, London Christmas Lectures, 1535
Science Teachers Summer School for (Australian Nuclear Research Foundation), 1108
Science Teaching French Journal of, 593
Science Writing, *review* by A L Bacharach, 1749
Science (Agricultural) Sixth Easter School in, at the University of Nottingham School of Agriculture (The Measurement of Grassland Productivity), 154
Science (Coal) Third Biennial International Conference on, 412
Science (Experimental) A History of Magic and (Prof Lynn Thorndike), Vols 7 and 8, The Seventeenth Century, *review* by Dr V A Eyles, 1899
Science (Forensic), Society for Meeting at the University of Nottingham to discuss the formation of a, 508
  Formation of the, 1271
Science (Modern) Darwin without, *review* by Sir Gavin de Beer, 385
Science (Nuclear), National Institute for Research in Contracts for work on the 7,000-MeV Proton Synchrotron *Nimrod*, B A 14
Science (Semi-Conductor) Advances in—Proceedings of the Third International Conference on Semi-Conductors, Rochester 1958 (edited by H Brooks), *review* by Dr J R Tillman, 1674
Science (Soil) Mineralogical Aspects of (Welsh Soils Discussion Group Discussion on), 156
Science (Soil), British Society of Discussion on Availability of Plant Nutrients, 159
Science (Soil), Indian Society of Presidential Address (Dr N R Dhar), 942
Science and Engineering Basic Geology for (Prof E C Dapples), *review* by Dr J C M Taylor, 1175
Science and the Humanities *review* by Dr H D Anthony, 131
Science in Industry Application of, 1827
Science in Industry—Policy for Progress (Prof C F Carter and Prof B R Williams), 1827
Science and Industry, Birmingham Museum of Account of the Workshops reconstructed in the (Keith Dunham), 1534
Science and the Library Services in Britain, 1455
Science and Literature, *review* by Dr W L Sumner, 5
Science and Magic (John Cain), 1535
Science and Philosophy (G E Denver), 1193

Science and Scepticism, *review* by Prof C K Grant, 1975
Science and Society, 127
Science and Technology Impact of, on Humanism, 1595
  Parliamentary Responsibility for, 1190
Science and Technology, National Lending Library for Appointment of a Consultative Committee, 1449
Science and Technology, Royal College of (Glasgow) Retirement of Sir David Anderson as director, 151
  Appointment of Dr S C Curran as director, 152
  Retirement of Prof F S Spring from the chair of chemistry, 233
  Appointment of Dr P L Pauson to the chair of chemistry, 233
Science and Technology (Vacuum), Joint British Committee for Formation of a, 1191
Science by the Upper Form (British Association for the Advancement of Science, Section X (Assembly of Corresponding Societies), Meeting on), 596
Science Education, *review* by Dr W L Sumner, 923
Science Education The Challenge of (edited by Joseph S Roucek), *review* by Dr W L Sumner, 923
Science Exhibition (1959) The Cape Town (Dr Ronald Singer), 952
Sciences, Enseignement des, Vol 1, No 1, 593
Sciences Biological, Vol 2 (edited by J G Bugher, J Coursaget and J F Loutit), (Progress in Nuclear Energy, Series 6), *review* by Prof G Pontecorvo, 1902
  Medical, Vol 2 (edited by J C Bugher, J Coursaget and J F Loutit), (Progress in Nuclear Energy, Series 7), *review* by Dr N M Blackett, 1766
  Origins and Methods of the, *review* by Prof A V Hill, 4
  Studies in the History and Methods of the (Prof Arthur David Ritchie), *review* by Prof A V Hill, 4
Sciences (Atmospheric) Advisory Panel on (United States National Science Foundation), 1022
Sciences (Medical), International Organizations of Abnormal Haemoglobins—a Symposium organized by the Council for (edited by J H P Jonxis and J F Delafresnaye), *review* by Dr J A M Ager, 840
Sciences (Natural), Swiss Society for 139th Annual Meeting (Dr R C H Tanner), 1454
  Presidential Address, La science, le savant et le pharmacien (Prof A Girardet), 1454
Sciences Naturelles de Belgique, Institut Royal des Memoire 143, Foraminifera of the Oligocene of Belgium (D A J Batjes), 321
Scientific Adviser to the United Kingdom High Commissioner in India, 1448
Scientific Background The (Prof A Norman Jeffares and M Bryn Davies), *review* by Dr W L Sumner, 5
Scientific Civil Service Special Promotions, 858
Scientific Courses (NATO) British Aid for, 406
Scientific Developments in Britain, 1190
Scientific Developments Mass Media of Communication and, 659
Scientific Hydrology, International Association of Symposium on the Effects of Forest Areas on Water Resources, 1184
  Symposium on the Technique of Lysimetry, 1184
Scientific Information (Soviet) Providing United States Scientists with (United States National Science Foundation), revised edition, 1611
Scientific Instrument Research Association (British) Changes in the publications, 320
  To produce an English translation, under the title *Instrument Construction*, of the Russian journal *Priborostroenie*, 592
Scientific Journals Effects of Printing Types and Formats on the Comprehension of (E C Poulton), 1824
Scientific Literature Chinese, 681
Scientific Man-power Problems in Britain, 1971
Scientific Method The Discipline of the, 295
Scientific Policy, Advisory Council on Annual Report for 1958-1959, 1897
Scientific Policy, Advisory Council on (Committee on Scientific Man-power) Report on Scientific and Engineering Man-power in Great Britain (1959), 1982
Scientific Policy of the Union of South Africa, Advisory Council on First and Second Annual Reports, 1191
Scientific Principles of Crop Protection (Hubert Martin), fourth edition, *review* by F C Bawden, 1258
Scientific Publications Distribution of, in Under-developed Countries (Scientific Publications Council Discussion on), B A 22
Scientific Publications of South and South-East Asia Bibliography of (Unesco Science Co-operation Office), Vol 5, No 6, 772
Scientific Publications Council Discussion on the Distribution of Scientific Publications in Under-developed Countries, B A 22
Scientific Relationships (International), Society for Promoting Special Medal awarded to Dr Detlev W Bronk, 1685
Scientific Research Central African, 407
Scientific Research in Alberta, 1370
Scientific Research in British Universities, 1958-59 (British Council), 854
Scientific Research in Great Britain, 1897
Scientific Research (Australian) Development Trends in, 1027
Scientific Research and the Philosophy of Science (British Society for the Philosophy of Science Symposium on), 1193
Scientific Revolution The Two Cultures and the (Sir Charles Snow), 295
  The Two Cultures and the (Dr W L Sumner), 411
Scientific Staff in New Zealand, 854
Scientific Term (New) Retentate, a (E G Turner and J G Feinberg), 1139
Scientific Unions, International Council of *I C S U Review*, No 1, 319, No 2, 408
  Yearbook 1959, 408
  Financial Statement for November 1957 to December 1958, 939
Scientific Unions, International Council of (International Atomic Energy Agency and the) Symposium on Radioactivation Analysis, 951
Scientific Unions Review, International Council of, No 1, 319, No 2, 408
Scientific and Engineering Man-power in Great Britain, 1959 (Report of the Committee on Scientific Man-power of the Advisory Council on Scientific Policy), 1982
Scientific and Industrial Research, Council for Second Report (1958), 780
  Appointment of Prof C F Carter as a member, 1362
Scientific and Industrial Research, Department of Building Research Station, National Building Studies Special Report No 28, Incentives in the Building Industry (Alison Entwistle and W J Reiners), 98
  Open Days at the Water Pollution Research Laboratory, B A 17
  Warren Spring Laboratory, Stevenage, 146
  Research for Industry 1958, a Report on Work done by the Industrial Research Associations in the Government Scheme, 211, 238
  To resume publication of *Technical Digests*, 410
  Productivity Measurement in Great Britain (T E Easterfield), 592
  Radio Research Board, Special Report No 27, The Calculation of the Median Sky Wave Field Strength in Tropical Regions (W R Piggott), 605
  Lending Library Unit list of Current Periodicals received from China, 681
  Open Days at the National Physical Laboratory, 773
  New Ship Hydrodynamics Laboratory of the National Physical Laboratory, 926
  Grants to the University of Oxford—£1,000 for research on some natural products with biological activity , £1,500 for research into perceptual limitations in high-speed performance , £22,860 for an investigation of the geological age of rock series by methods based on natural radioactivity , £1,220 for equipment for research on the biochemical mechanism of cell division , £22,725 for an investigation of materials, using magnetic resonance and double resonance techniques , and £17,610 for an investigation of nuclear orientation and nuclear cooling in magnetic fields, 943, 1273
  Grant of £6,000 a year for five years to the National Institute of Industrial Psychology, 940
  Report of the National Physical Laboratory for 1958, 954
  Report of the Building Research Board with the Report of the Director of Building Research, 1023
  Radio Research Board, Special Report, No 28, Conversion of Ionospheric Virtual Height-Frequency Curves to Electron Density-Height Profiles (Dr J O Thomas and M D Vickers), 1024
  Grants to the University of Leeds—£1,835 towards the cost of cosmic-ray research, in the Department of Physics, £12,000 for an investigation into high-pressure chemistry and geochemistry , £3,000 for research by Dr P Gray in physical chemistry , and £1,050 for research in high alumina cements, 1108
  Crushing and Grinding, a Bibliography, *review* by Prof S G Ward, 1177
  Grant of £6,000 to the Department of Chemistry in the University of Hull, towards the purchase of a mass spectrometer, 1273
  Grant of £3,400 to the University of Oxford, for the maintenance of the 140 MeV synchrotron for nuclear physics research, 1362
  Grant of £35,900 to the University of Oxford, for research on high-energy phenomena using photographic plates, 1535
  Water Pollution Research 1958—the Report of the Water Pollution Research Board with the Report of the Director of the Water Pollution Research Laboratory, 1542
  Retirement of Dr D D Pratt from the directorship of the National Chemical Laboratory, 1610
  Appointment of Prof J S Anderson as director of the National Chemical Laboratory, 1610
  Grants to the University of Bristol—£16,680 to the Department of Physics, for research in cosmic radiation with balloons, photon-induced cascades at different altitudes, and time variations in the primary cosmic radiation over Great Britain , £35,084 to the Department of Psychology, for research into the complexity of industrial tasks , to the Department of Geology, £5,000 for investigations of feldspars in the Connemara granite series and preferred orientation in rock-forming minerals, and £3,550 for investigations of the submarine geology of the continental shelf of the Western Approaches of the English Channel , £3,850 to the Department of Physical and Inorganic Chemistry, for equipment , and £2,880 to the Department of Zoology, for investigations of the physiological basis of behaviour in protozoa, 1613
  Report of the National Chemical Laboratory for 1958, 1779
  Appointment of Dr G Macfarlane as deputy director of the National Physical Laboratory, 1844
Scientific and Industrial Research, South African Council for Thirteenth Annual Report (1957-58), 1449
Scientific and Industrial Research Organization (Australian Commonwealth) Grant of 30,000 dollars for the Rockefeller Foundation, for special equipment for the new Division of Tropical Pastures, 93
  Grant of 100,000 dollars from the Rockefeller Foundation, for the Divisions of Plant Industry and of Entomology, 93
  Grant of 250,000 dollars from the Rockefeller Foundation, towards the cost of the radio telescope for the Division of Radiophysics, 93
  Formation of a Division of Mineral Chemistry, 237
  Appointment of Dr F W G White as chairman, 317
  Appointment of Dr R N Robertson as a full-time member of the Executive, 317
  Rural Research in C S I R O, 27, Fencing Posts in Australia, 321
  List of Divisions and Sections, 410
  Tenth Annual Report (1957-58), 1027
  Second Australian Spectroscopy Conference, 1195
  Symposium on the Structure and Chemistry of Proteins, 1276
  Retirement of D A Gill as chief of the Division of Animal Health and Production, 1532
  Appointment of Dr J M Rendel as chief of the Division of Animal Genetics, 1532
  Appointment of Dr T S Gregory as chief of the Division of Animal Health, 1532
  Appointment of Dr I W McDonald as chief of the Division of Animal Physiology, 1532
  Cunningham Laboratory of the, 1776
  Appointment of C S Christian and Prof L G H Huxley as members of the Executive, 1984
  Appointment of G B Gresford as secretary, 1985
  Appointment of W Ives as executive officer, 1985
Scientific and Technical Books Recent, Supp v, July 25 , Supp iv, August 29 , Supp v, September 26 , Supp iv, October 31 , Supp vi, November 28 , Supp iv, December 26
Scientific and Technical Personnel Programme of National Information on (United States National Science Foundation to establish and maintain a), 592
Scientific and Technical Persons Registration of (1958), 854

Scientific and Technological Research in Britain Organization of, 1255

Scientist (Social) Air Surveys and the (Leo Silberman), 244

Scientists Pugwash International Conference of—Statement on Biological and Chemical Warfare, 1018

Scientists in the Public Service in Britain Special Promotions, 858, 1273

Scientists and Engineers in Britain, 1982

Scientists (Consulting), Association of Election of Officers, 508, 1777

Scientists (United States) Providing, with Soviet Scientific Information (United States National Science Foundation), revised edition, 1611

Scientists (United States and Soviet) Exchanges between, 680

Sclereid Formation in the Leaf of *Camellia japonica* Pattern and Control of (Donald E Foard), 1663

Sclerosis (Multiple) Geology and (Prof Harry V Warren), 561

Sclerotized Whole Insects Sectioning Large Heavily (Prof W E Beckel), 1584

Scoggan, Sybil M (Ettori, Prof J, and) Ionized Calcium in Biological Media, 1315

Scolytid Beetle Release by Exercise Flight of a Chemotropic Response from Photopositive Domination in a (Prof Kenneth Graham), 283

Scotland The Native Pinewoods of (Prof H M Steven and A Carlisle), *review* by Prof E W Jones, 133

Scotland (North-West) Rubidium-Strontium Ages of Lewisian Rocks from (Dr Bruno J Giletti), 1793

Scott, Dr A I The Chemistry of Vegetable Tannins, *review*, 1832

  Tracer Applications for the Study of Organic Reactions, *review*, 1902

Scott, C G Gas Chromatography (Alumina as a Packing), 328

  Progress in Gas Chromatography, 1199

Scott, D W Thermodynamics (Experimental Thermochemistry), 1607

Scott, Prof G David Substrate Damage in Film Thickness Measurement by Beam Interferometry, 354

Scott, Dr G R Heat Inactivation of Rinderpest-infected Bovine Tissues, 1948

Scott, Dr John Paul Animal Behaviour, *review* by Dr F Fraser Darling, 302

Scott, Dr Patricia P, and Lloyd-Jacob, Marny A Reduction in the Anoestrus Period of Laboratory Cats by Increased Illumination, 2022

Scott, Dr Russell B Cryogenic Engineering, *review* by Dr G G Haselden, 1174

Scott, R P W Gas Chromatography (Use of Fine Nylon Tubes as Capillary Columns), 328

  Gas Chromatography (Presentation of Gas Chromatographic Data with a High-persistence Cathode Ray Tube), 1199

Scott Base Radiation Balance at (D C Thompson and W J P Macdonald), 541

Scottish Highlands Conservation in the (Scottish Branch of the Institute of Biology Symposium on), 1529

Scripps Institution of Oceanography Oceanographic and Geophysical Investigation of the western Pacific Ocean and eastern Indian Ocean, 24

  Symposium on Perspectives in Marine Biology, 1956 (edited by A A Buzzati-Traverso), *review* by Dr J A Allen, 215

Scrolls (Dead Sea) A New Approach to the Dating of the (Prof D Burton, J B Poole and Dr R Reed), 533

Scurlock, Dr R G Appointed lecturer in physics at the University of Southampton, 595

Sea Living Resources of the (Dr Lionel A Walford), *review* by Dr F S Russell, 129

  The Open—its Natural History (Sir Alister Hardy), Part 2, Fish and Fisheries, with Chapters on Whales, Turtles and Animals of the Sea Floor, *review* by S M Marshall, 666

Sea, Co-ordinating Advisory Committee on Oil Pollution of the International Conference, 949

Sea, International Council for the Exploration of the Special International Geophysical Year Meeting (A J Lee and Dr D H Cushing), 1180

Sea (Dead) Scrolls A New Approach to the Dating of the (Prof D Burton, J B Poole and Dr R Reed), 533

Sea (Deep-) Ash Origin of the Worzel (Edward Anders and Dr D Nelson Limber), 44

Sea (Deep) Fauna Palaeotemperatures and the Origin of the, 1025

Sea (Deep) Jellyfish A Viviparous (Dr F S Russell), 1527

Sea (Ross) An Oceanographic Survey of the (J S Bullivant), 422

Sea Anemone (*Calliactis parasitica*) and the Hermit Crab (*Eupagurus bernhardus*), (Dr D M Ross), 1161

Sea-bottom (Soft), in Arctic North America The Benthos of (Dr D V Ellis), B A 79

Sea Fisheries Research in East Africa, 855

Sea-Horse and its Relatives (Gilbert Whitley and Joyce Allan), *review* by T H Hawkins, 390

Sea Urchin, *Diadema setosum* (Leske) Isolation of Echinochrome *A* from the Spines of the (Kokichi Nishibori), 1234

Sea Urchin Egg An Inhibitor of Cytochrome Oxidase Activity in the (Rachele Maggio and Alberto Monroy), 68

Sea Urchins Behaviour of (A N Sinclair), 783

Seaborg, Prof Glenn T The Transuranium Elements, *review* by Dr J K Dawson, 922

Seaman, J At the ninth International Starch Convention (Use of Starch as Sizing Agent in the Paper Industry), 514

Seamer, P A Estimation of μgm Quantities of Iron in Culture Medium, using Bathophenanthroline, 636

Search of a Conclusion Forty-seven Authors in, *review* by N W Pirie, 920

Search for Neutral Atomic Hydrogen in Globular Clusters (Dr Morton S Roberts), 1555

Searching for Interstellar Communications (Giuseppe Cocconi and Philip Morrison), 844

Searle, A G Hereditary Absence of Spleen in the Mouse, 1419

Searle, C E Effect of Polycyclic Aromatic Hydrocarbons on the Polarographic Maximum of Copper, 1716

Seas (Ancient) Determination of the Temperatures of, by the Measurement of the Oxygen Isotopes Ratio in Fossil Calcareous Organisms (Y A Birstein), 1025

Seas (British) *Acanthocottus lilljeborgi* (Collett) in (P J Miller), 1162

Season Influence of Site and, on Agricultural Variety Trials (A Sandison), 834

Seasonal Changes in the Œstrous Response by the Ovariectomized Ewe to Progesterone and Œstrogen (Prof J I Raeside and M F McDonald), 458

Seasonal Rhythm in the Presentation of Bone Sarcoma in Man (Dr C H G Price), B A 76

Seasonal Sex Difference in the Infestation of Rabbits with the Nematode *Trichostrongylus retortaeformis* (Zeder, 1800), (P C Bull), 281

Seaway and Power Projects The St Lawrence—Geographical Background (Prof T L Hills), B A 49

Sebba, Prof F Concentration by Ion Flotation, 1062

Secker, P E Ionization Phenomena in Gases (Arcs in Transverse Magnetic Fields), 1355

Second World War U S Army Neurosurgery in the, *review* by J E A O'Connell, 1676

Secondary Modern Schools Mathematics in (Mathematical Association Discussion of the Report on), 32

Secondary Structure in Proteins exposed to Ionizing Radiations in the Solid State Disorganization of the (Dr Peter Alexander, L D G Hamilton and Dr K A Stacey), 226

Secondary Structure of Ribonucleic Acid in Solution (Dr R A Cox and Dr U Z Littauer), 318

Secondary and Higher Education in Britain, 1671

Secretion of Adrenocortical Steroids Biosynthesis and (Biochemical Society Symposium on), 415

Secretion from the Denervated Adrenal Medulla Effects of Reserpine on (L Stjarne and S Schapiro) 2023

Secretion of Wax through the Cuticle of Insects (Dr M Locke), 1967

Secretion (Acid-) Defensive, in some Marine Gastropods (Dr T E Thompson), 1162

Secretion (Adrenal Medullary), of Catechol Amines Effects of 1,4-Dihydrazinophthalazine on Organ Content and (M Bygdeman and L Stjarne), 1646

Secretion (Milk) Potassium and Lactose in Milk in relation to the Physiology of (Dr J A F Rook and Marian Wood), 647

Sectioning Large Heavily Sclerotized Whole Insects (Prof W E Beckel), 1584

Sections (Neutron-activated) Distribution of Sodium in Compact Bone, as revealed by Autoradiography of (Prof J Vincent), 1332

Sections and Smears Fluorescent Schiff-Type Reagents for Cytochemical Detection of Polyaldehyde Moieties in (Prof Frederick H Kasten, Vivian Burton and Peggy Glover), 1797

Sectors (Distinct), in Polymer Single Crystals Evidence for (D C Bassett, Prof F C Frank and Dr A Keller), 810

Secular Solar Activity Changes in the Climate of the Atlantic–European Area and (Z Gregor and L Krivksy), 682

Sedimentation Rates, Fluidization and Flow through Porous Media (Colin C Harris), 716

Sedimentation and Effective Viscosity (Prof G J Kynch), 1311

Sedlund, F R, and Chang, Prof C C Blunt-Nosed Bodies in a High-Temperature Gas Jet, 812

Seed A Quick Method for Extracting Plant Embryos from certain Types of (M D Gwynne), 1588

Seed Dormancy Prevention of the Onset of, by Gibberellic Acid (Dr M Black and J M Naylor), 468, *erratum*, 857

Seed Germination (Educational Productions, Ltd, Filmstrip CX 6290), 1777

Seedless Hops Production of, by Interspecific Pollination (Prof Edward L Davis), 1336

Seedlings of *Musa balbisiana* A Rapid and Simple Pathogenicity Test for Detecting Virulent Clones of *Fusarium oxysporum* f *cubense* using (Dr R H Stover), 1591

Seedlings (Birch) Early Induction of Flowering in (Dr K A Longman and Prof P F Wareing), 2037

Seedlings (Coconut) Albinism in (Dr K M Pandalai and R V Pillai), 1163

Seedlings (Coniferous) Antibacterial Substances of, at Different Stages of their Development (R Vamos and L Vida), 915

Seedlings (*Sequoia sepervirens* (D Don) Endl and *Pseudotsuga menziesii* (Mirb) Franco) Response of, to Temperature (Henry Hellmers and William P Sundahl), 1247

Seedlings (*Striga*) Action of Inhibitor-β on the Growth of (C N Williams), 1577

Seeds (Peach) Gibberellic Acid and the Chilling Requirements of (the late Prof Margaretha G Mes), 2034

Seeds (X-Rayed), of High and Low Water Content Free Radicals in, as Measured by Electron Spin Resonance (Dr W Klingmuller, Dr G R Lane, M C Saxena and Dr D J E Ingram), 464

Segel, Dr R E Nuclear Forces and the Few-Nucleon Problem (Binding Energies and Elastic Scattering of Light Nuclei at Low Energies—Polarization Measurements in *n-d* and *p-d* Scattering at Low Energies), 1114

Segerstedt, Prof Torgny Opening Address at the Fourth International Conference on Ionization Phenomena in Gases, 1353

Segre, Dr Emilio, and Chamberlain, Dr Owen Awarded the Nobel Prize for Physics for 1959, 1189 , work of, 1189

Seismologie, Bureau Central International de Report of the Meetings of the Section for Seismology and the Physics of the Earth's Interior (Dr Markus Bath), 154

Seismology Recent Work in the Soviet Union in the field of (Committee on Geodesy and Geophysics of the Academy of Sciences of the U S S R Report on), 322

Seitz, Dr Chemistry of Propellants, 778

Seitz, Frederick, and Turnbull, David (edited by) Solid State Physics, Vols 4, 5 and 6, *review* by Prof E C Stoner, 1753

Sekiguchi, Dr Mutsuo, and others Induction of Phage Formation in the Lysogenic *Escherichia coli K*-12 by Mitomycin *C*, 1079

Sekiya, Prof A, and others Chemistry and Pharmacology of 16-Acetyl Digitalinum Verum, 1414

Selby Fellowship (Australian Academy of Science), 684

Select Committee on Estimates, Session 1958-59 Seventh Special Report, Treasury Control of Expenditure (Observations of the Treasury), 696

Selection Factors in a Tropical Trawl Fishery Prediction of (Alan R Longhurst), 1170

Selection Theory (The Clonal), of Acquired Immunity (Sir Macfarlane Burnet), *review* by Dr J H Humphrey, 753

Selective Feeding in Female *Calliphora erythrocephala* Meig Hormonal Control of (J Strangways-Dixon), 2040

Selective Inhibition of Ribonucleic Acid Synthesis in *Staphylococcus aureus* by Vancomycin (Prof D C Jordan and W E Inniss), 1894

Selective Oxidation of Tetrapyrrole Side-Chains (J Barrett and P Clezy), 1988
Selenium Curative Effect of, upon the Incisor Teeth of Rats deficient in Vitamin E (Prof J T Irving), 645
  Growth Responses to, in Lambs (Dr J W McLean, G G Thomson and J H Claxton), 251
Selenium and Cystine An Effect of, on Lipide Peroxidation in Tissues Deficient in Vitamin E (Dr John G Bieri), 1148
Self-Regulation in Living Systems (Second Ottawa Symposium on), 239
Sell, G , and Dossett, H A (edited by) Handbook of the Petroleum Industry, *review*, 1832
Sellers, Prof A F , and Titchen, Dr D A Responses to Localized Distension of the Oesophagus in Decerebrate Sheep, 645
Sellschop, Dr J P F Appointed to the chair of nuclear physics in the University of the Witwatersrand, 233 , work of, 233
Selye, Prof Hans Diaphragms for Analysing the Development of Connective Tissue, 701
Semenov, N N Some Problems in Chemical Kinetics and Reactivity, Vol I (translated by Michael Boudart), *review* by Dr T M Sugden, 299
Semi-Albino, a Third Sex-linked Allelomorph of Silver and Gold in the Fowl (W F Werret, A J Candy, J O L King and Dr P M Sheppard), 480
Semiconducting Diamond after Heat Treatment Electrical Resistivity Changes observed in a (R E Mutch and Dr F A Raal), 1857
Semiconducting Silicon Carbide (Dr H K Henisch), 158
Semiconductive Properties of Dilute Binary Solid Solutions of Bismuth in Tellurium and Tellurium in Bismuth Some (Dr Tomasz R Piwkowski), 355
Semiconductor Devices Transistors and Associated (Electronics and Communications Section of the Institution of Electrical Engineers International Convention on), 693
Semiconductor Science Advances in—Proceedings of the Third International Conference on Semi-Conductors, Rochester 1958 (edited by H Brooks), *review* by Dr J R Tillman, 1674
Semiconductor Surfaces (United States Office of Naval Research Second Conference on), 1192
Semiconductors, *review* by Dr R A Hyman 1754
Semiconductors Fluctuating Phenomena in (Prof A Van der Ziel), *review* by Dr R A Hyman, 1754
  An Introduction to the Theory and Practice of (Dr A A Shepherd), *review* by Dr R A Hyman, 1754
  Optical Properties of (Dr T S Moss), *review* by Dr R A Hyman, 1754
  Proceedings of the Third International Conference on, Rochester 1958 (Advances in Semi-Conductor Science, edited by H Brooks), *review* by Dr J R Tillman, 1674
  Progress in (edited by Dr Alan F Gibson, Prof R E Burgess and Prof P Aigrain), Vol 3, *review* by Dr R A Hyman, 1754
  Rochester Conference on, *review* by Dr J R Tillman, 1674
Semi-microchemical Methods Micro- and (Norwood Technical College Course of lectures and practical work on), 1845
Seminal Plasma, Serum and Bile Visualization of Acid and Alkaline Phosphatase after Starch-Gel Electrophoresis of (Dr Bengt Estborn), 1636
Seminal Vesicle Influence of Sexual Stimulation on the Metabolic Activity of Deoxyribonucleic Acid in the (Dr S R Pelc), 1414
Seminiferous Tubules of the Rat Residual Bodies of (B V Kingsley Smith and Dr D Lacy), 249
Semipermeability of Plant Cell Membranes Maintenance of, in the Absence of Metabolic Energy Supply (Dr B Ginzburg), 1073
Sen, Dhruba K Uraemia and its Treatment by Arginase Inhibitor, 459
Sen, Dr Randjit Transaminases in *Shigellae*, 741
Sen Gupta, S P (Chakraborty, S P , and) Fixation of Nitrogen by the Rice Plant, 2033
Senebier, Jean (1742-1809), 152
Senftle, F E , and others α-Radioactivity of Cerium-142, 630
Seno, Tamikazu, and Saito, Saburo A Chimaeric Duck with the Head of a Chick, B A 78
Sensenbrenner, M , and others Distribution of Nucleic Acids among Different Stable L Forms of *Proteus P* 18, 566
Sensitive Assay Method (Specific and), for Vasopressin and Oxytocin using Glass-Paper Chromatography (Akira Arimura and Prof Joseph F Dingman), 1874
Sensitive Chemical Dosimeter for Ionizing Radiation (Prof Gerald Oster and Dr Barret Broyde), 545
Sensitive Method (A Rapid and), for the Determination of Xanthine Oxidase Activity using the Oxygen Electrode (Metry Bacila and Dr Gilberto G Villela), 1394
Sensitive Strains of the Blue Tick, *Boophilus decoloratus* Contents of Cystine-Cysteine, Glutathione and Total Free Sulphydryl in Arsenic-resistant and (Dr J S Harington), 1739
Sensitivity of Catharometers in Gas Chromatography and the Thermal Conductivity of Binary Gas Mixtures (A B Littlewood) 1631
Sensitivity in Gas Chromatography Carrier Gas and (E M Fredericks, M Dimbat and F H Stross), B A 54 , (Dr N H Ray), B A 54
Sensitivity (Directional) A Functional Interpretation of the Electron-Microscopic Structure of the Sensory Hairs in the Cristae of the Elasmobranch *Raja clavata* in Terms of (Prof O Lowenstein and J Wersall), 1807
Sensitivity (Extreme), of Germination and Photoperiodic Reaction in the Genus *Chenopodium* (Tourn) L (Dr Bruce G Cumming), 1044
Sensitivity (Insulin-), of the Rat Diaphragm *in vitro* Role of Magnesium in the (Dr Gangagobinda Bhattacharya), 1401
Sensitivity (X-Ray), and Target Volume of Enzyme Induction (Dr Helmut Pauly), 1570
Sensitization (Passive), of Isolated Plain Muscles with Precipitating Antibody Promoting Effect of Urea on the *in vitro* (R Binaghi, Dr B N Halpern, P Liacopoulos and T Neveu), 1805
Sensitizing Factor (Histamine) Formation of the Toxoid of, in *Bordetella pertussis* (Prof Toshitaka Matsui and Yoshio Kuwajima), 199
Sensory Hairs in the Cristae of the Elasmobranch *Raja clavata* A Functional Interpretation of the Electron-Microscopic Structure of the, in Terms of Directional Sensitivity (Prof O Lowenstein and J Wersall), 1807
Sensory Mechanisms Haemoglobin and, *review* by P A Merton, 1092
Separating Power of Packed and Capillary Gas Chromatographic Columns Comparison of Efficiency and (Dr J H Purnell), 2009
Separation of Amino-acids A New Two-Dimensional Paper Chromatographic Method applied to the (C S Knight), 1486
Separation of Amino-Acids and Peptides on Paper A Two-Dimensional System for the (Virginia Richmond and Brian S Hartley), 1869
Separation of Antigenic Components from Isolated Nuclei Transplantation Immunity— (Andre Castermans and Andre Oth), 1224
Separation of Fast-Moving γ-Globulins by Starch-Gel Electrophoresis (Dr M D Poulik, Dr W W Zuelzer and Dr R Meyer), 1800
Separation by Gamma-Irradiation of Two Elements at the Vbs Locus in *Trifolium repens* (Dr D Roy Davies and E T Wall), 1957
Separation of the *Meta*- and *Para*-Isomers of the Xylenes, Cresols and Toluidines by Gas Solid Chromatography (M A Hughes, D White and Prof A L Roberts), 1796
Separation of Polyvinyl Chloride and Polyvinyl Acetate by Chromatographic Methods (W J Langford and D J Vaughan), 116
Separation of Prealbumins by Starch Gel Electrophoresis (Dr M D Poulik), 1067
Separation (Gas Chromatographic), of Long-chain Fatty Acid Methyl Esters on Polyvinyl Acetate (Irwin Hornstein, L E Elliott and P F Crowe), 1710
Separation (Paper Chromatographic), of Components of Rose Bengal Labelled with Iodine-131 (Fausto W Lima and Rômulo R Pieroni), 1065
Sequence (Terminal Peptide), of Human Haemoglobin ’ (Dr J A Hunt and Dr V M Ingram), 640
Sequoia sepervirens (D Don) Endl and *Pseudotsuga menziesii* (Mirb) Franco Seedlings Response of, to Temperature (Henry Hellmers and William P Sundahl), 1247
Sera (Agglutinating), and the Corresponding Red Blood Cell Receptors Influence of Streptomycin Solutions on the Interaction between the (Dr M Kout and Dr Z Kubickova), 639
Sercarz Dr E , and Coons, Dr A H Specific Inhibition of Antibody Formation during Immunological Paralysis and Unresponsiveness, 1080
Serine A Micromethod for the Polarographic Determination of (J Ladik and Dr I Szekacs), 188
L-Serine Phosphate Crystal Structure of (G H McCallum, Prof J Monteath Robertson and Dr G A Sim), 1863
Sermonti, G Cytoplasmic Inheritance (Cytoplasmic Inheritance in *Penicillium*), 1012
Serological Distinction of Adult and Foetal Human Haemoglobin (G R E Naylor and M E Adair), 1854
Serotonin Release of Adenosine Triphosphate and, from Injured Cellular Blood Elements in Extracorporeal Circuits (Dr H S S Sarajas, Dr R Kristoffersson and Dr M H Frick), 1127
Serotonin Metabolism A New Inhibitor of (Dr Alfred R Maass and Mary Jane Nimmo), 547
Serrel, F , and others Low-Temperature Autoradiography for the Detection of Tritium in Tissue, with Removal of Luminescence induced by Tritium, 1385
Serum (Acidified Rat) Peptides with Oxytocic and Pressor Activity obtained from (Prof H Croxatto, T Pereda and R Mellada), 1496
Serum (Anti-Rh) Specific Inhibition of, by 'Unnatural' Sugars (Dr William C Boyd, Marjorie H McMaster and Eugenia Waszczenko-Zacharczenko), 989
Serum (Blood) Determination of Magnesium in, by Atomic Absorption Spectroscopy (Dr J B Willis), 186
Serum (Human) Activation and Inhibition of the Arylesterase of (Prof E G Erdos, C R Debay and M P Westerman), 430
Serum (Human), in Cell Culture Growth-Controlling Action of (Dr Kari Penttinen and Dr Erkki Saxen), 1570
Serum (Human), denatured with Tannin Effect of Ultrasound on the Protein of (Dr Wizold Mizgalski and Irena Zygmunt), 1486
Serum (Normal Human) Effect of Coagulase on the Growth of Staphylococci in (Dr K Wlodarczek and Dr J Jeljaszewicz), 1514
Serum Albumin Production of, and of Globulins by Chick Mesenchymal Tissue and by HeLa Tumour Tissue in Culture (Y Abdel-Samie, Prof E Broda, G Kellner and W Zischka), 361, *erratum*, 943
Serum Cholesterol in Rats Dietary Protein and (A P de Groot), 903
Serum Factor Transformation Reaction of Pneumococci in the Absence of (Prof Takeshi Odaka and Tadashi Watanabe), 471
Serum Inhibitors of Asian Strains of Influenza Virus (Suzanne M James and Paul Fiset), 1656
Serum Protein Changes in the Level of, during Treatment of Kwashiorkor (Dr Olumbe Bassir), 2019
Serum Proteins (Substituted Human) Modifications in Immunological Behaviour, Electrophoretic Mobility and Colourability of (M Steinbuch, Dr J M Fine and A Battistini), 1571
Serum and Bile (Seminal Plasma,) Visualization of Acid and Alkaline Phosphatase after Starch-Gel Electrophoresis of (Dr Bengt Estborn), 1636
Serventy, Dr D L (Marshall, Dr A J , and) Experimental Demonstration of an Internal Rhythm of Reproduction in a Trans-Equatorial Migrant (the Short-tailed Shearwater *Puffinus tenuirostris*), 1704
Service Medals of the Textile Institute awarded to Walter Garner and Dr A R Urquhart, 156
Service (A New), for Naturalists (R S R Fitter), 1774
Service (Public), in Europe The Profession of Government—the (Dr Brian Chapman), 127
Service (State) Creative Leadership in a—a General Survey (Sir George Schuster), (Hospitals and the State—Hospital Organization and Administration under the National Health Service, Sixth and Final Research Report), 1087, 1201
Services (Public), in a Modern Democracy The Development of, 1087
Services Electronics Research Laboratory Symposium on Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques, 690
Seshachar, Prof B R , and Padmavathi, P B Conjugation in *Spirostomum*, 1510
Sesquiterpenoids Mono- and (P de Mayo), (The Chemistry of Natural Products, Vol 2), *review* by Prof A J Birch, 754
Sestan, N (Stankovic, Dr V , and) Effect of Whole-body X-Irradiation on the Insulin Resistance of Fasted Rats, 1816

Set (Permanent), Supercontraction, and Urea-Bisulphite Solubility—the Proton-Transfer Nature of some Changes in Keratin and the Analogy with Muscle Contraction (Dr P T Speakman), 339

Set Theory Axiomatic (Prof Paul Bernays), *review* by Dr L S Goddard, 1178

  Foundations of (Prof Abraham A Fraenkel and Prof Yehoshua Bar-Hillel), *review* by Dr L S Goddard, 1178

Setchell, Dr B P Effects of Carbon Tetrachloride on Kidney and Liver Function in the Sheep, 1242

Setnikar, Dr I, and others N-Substituted 7-Methoxy-8-Aminoethylchromones and Flavones—New Brain-Stem Stimulants, 362

Setterfield, G, and others Fine Structure in Cells of Pea and Wheat Embryos, 505

Setting of Gypsum Plaster Effect of Temperature on the Rate of (M J Ridge), 47

Sevitt, Dr S Toxaemia after Burning, *review*, 5

Sewage Disposal (River Pollution), and Trade Waste Treatment (Department of Civil Engineering and the Department of Extra-Mural Studies in the University of Birmingham Course on), 1451

Sewell, B W (Rappoport, Prof D A, and) Metabolic Changes induced in Mammalian Erythrocytes by Whole-body X-Irradiation, 846

Sewell, I A (Nicol, Prof T, and) Effect of Sulphonamides on the Phagocytic Activity of the Reticulo-Endothelial System, 1241

Sex Grants-in-aid for Research in Problems of (United States National Academy of Sciences—National Research Council), 1107

Sex Chromatin in Cultured Human Tissues (Dr Charles P Miles), 477

Sex Chromatin ('Chromoleme') in the Purkinje Nerve Cells of some Mammals (Nylceo Marques de Castro and Wilson da Silva Sasso), 293

Sex Chromatin Pattern in the Male Rat Effect of Sexual Maturation and Castration on the (St Zsifkovits, Ch Mehes and C Jobst), 1239

Sex Difference in Ethanol Tolerance of Rats (Henrik Wallgren), 726

Sex Difference in the White Blood Cells of Rats (WR Strain), (Dr Hans Meier), 1082

Sex Difference (A Seasonal), in the Infestation of Rabbits with the Nematode *Trichostrongylus retortaeformis* (Zeder, 1800), (P C Bull), 281

Sex Research, 1107

Sex on the Farm, *review* by Dr S J Folley, 1091

Sex-linked Allelomorph of Silver and Gold in the Fowl Semi-Albino, a Third (W F Werret, A J Candy, J O L King and Dr P M Sheppard), 480

Sexual Cycle Periodic Acid-Schiff-Positive Material and Alkaline Phosphatase in the Uterine Wall of the Pig during the (Rolv Austad and Dr Otto Garm), 999

Sexual Maturation and Castration Effect of, on the Sex Chromatin Pattern in the Male Rat (St Zsifkovits, Ch Mehes and C Jobst), 1239

Sexual Stimulation Influence of, on the Metabolic Activity of Deoxyribonucleic Acid in the Seminal Vesicle (Dr S R Pelc), 1414

Seybold, A, and Goodwin, Prof T W Occurrence of Astaxanthin in the Flower Petals of *Adonis annua* L, 1714

Seyler, A J, and Budrikis, Z L Measurements of Temporal Adaptation to Spatial Detail Vision, 1215

Seymour, R C (Ehretsmann, J H, and) Coal Science (Gaseous Products and Thermochemistry of the Formation and Decomposition of Surface Oxides on Charcoals), 414

Seymour, W D Ergonomics, its Place in Industry, B A 21

Seymour Island, Antarctica Fossil Pollen from (Lucy M Cranwell), 1782

Shack, Joseph, and Bynum, Barbara S Determination of the Interaction of Deoxyribonucleate and Magnesium Ions by means of a Metal Ion Indicator, 635

Shackel, B Ergonomics, its Place in Industry (Design Problems in E M I Electronics), B A 21

Shadow Substance and, *review* by Prof R V Jones, 1752

Shafa, Dr F, and Salton, Dr M R J Release of Compounds containing Diaminopimelic Acid from *Vibrio metchnikovi* treated with Antibody and Complement, 1341

Shape of Protein Molecules suggested by Electron Microscopy (Dr R C Valentine), 1838

Shape (Molecular), and the Physical Properties of Mucin (R A Gibbons), 610

Shapiro, Dr M B Appointed to the University of London readership in psychology at the Institute of Psychiatry, 595

Shapley, Dr Harlow Of Stars and Men, *review* by Dr W L Sumner, B A 3

Shappirio, David G, and others Oxygen Uptake of Glycerol-extracted Muscle Fibres, 1947

Sharaf, A, and others *In vitro* Study of the Anthelminthic Property of *Artemesia monosperma* grown in Egypt, 647

Sharbaugh, A Harry, and Watson, P Keith Conduction Currents in Liquid *n*-Hexane under Microsecond Pulse Conditions, 2006

Sharma, Dr Archana Tumour Production in Plants by Plant Extracts, 1083

Sharma, Dr Arun Kumar, and Gupta, Arati Chromosome Breakage with Plant Pigments, 1821

Sharnoff, Dr J George A Possible Explanation of the Formation of Long Platelets from Pulmonary Megakaryocytes, B A 75

Sharp, A J Origin and Dispersal of Flowering Plants (Flora of the newer Coastal Plains of Tennessee and the Glaciated Terrain to the North), 1200

Sharp, Dr D W A Modern Inorganic Chemistry, *review*, 1756

Sharp, John A Use of Transparent Cellulose Film for Roller Tube Tissue Cultures, 1508

Sharpe, Dr A G Principles of Oxidation and Reduction, *review* by Dr V Gold, 1902

Sharpe, Dr A G (edited by Prof H J Emeléus and) Advances in Inorganic Chemistry and Radiochemistry, Vol I, *review* by Dr D W A Sharp, 1756

Sharpe, H S Cytoplasmic Inheritance (Closed and Open Systems of Extra-nuclear Inheritance in *Aspergillus*), 1012

Sharples, R O *Gloeosporium* in Apple Stem Wounds, 243

Sharrock, J T R Awarded a Nature Conservancy Research Studentship for postgraduate training in ecology (botany), 156

Shasha, Baruch, and Leibowitz, Prof Jeshaia Oleuropeic Acid, a New Compound from *Olea europaea*, 2019

Shaw, Dr Kenneth N F, and others Urinary Excretion of β-Amino-isobutyric Acid in Mongolism, 1970

Shear, M J, and others Reduction of Toxicity of Cationic Macromolecules by Complexing with Anionic Derivatives of Synthetic Polyglucoses, 431

Shearwater *Puffinus tenuirostris* (Short-tailed) Experimental Demonstration of an Internal Rhythm of Reproduction in a Trans-Equatorial Migrant, the (Dr A J Marshall and Dr D L Serventy), 1704

Shedding (Coat-), in a Tropical Breed of Hair Sheep Light Regulation of (R B Symington), 1076

Sheehan, John C (edited by) Organic Synthesis, Vol 38 (1958), *review* by Prof John Read, 134

Sheep Blood Cortisol in the—Normal Concentration and Changes in Ketosis of Pregnancy (H R Lindner), 1645

  Effects of Carbon Tetrachloride on Kidney and Liver Function in the (Dr B P Setchell), 1242

  Excretion of Labelled Magnesium by the (D C Macdonald, A D Care and B Nolan), 736

  Loss of Wool in, caused by 1-*p*-Aminophenoxy-5-phthalimidopentane (Dr D L Hughes), 1644

  Relationship between *p*H and Volatile Fatty Acid and Diversion of Saliva from the Actively Fermenting Rumen of (W R McManus), 1572

Sheep in the Field *Sporidesmium bakeri* and Facial Eczema of (R H Thornton and D P Sinclair), 1327

Sheep (Copper-deficient) Experiments on Wool from (R W Burley and F W A Horden), 1725

Sheep (Decerebrate) Responses to Localized Distension of the Oesophagus in (Prof A F Sellers and Dr D A Titchen), 645

Sheep (Foetal and Adult) Inositol Concentration in the Cerebrospinal and Ocular Fluids and Tissues of the (D A Nixon), 906

Sheep (Hair) Light Regulation of Coat-Shedding in a Tropical Breed of (R B Symington), 1076

Sheep (New Zealand) Composition of some Fat-free Carcasses and Bodies of (A H Kirton, M J Ulyatt and R A Barton), 1724

Sheeps' Teeth Cause of Wear in (Dr G Baker, Dr L H P Jones and I D Wardrop), 1583

Sheffield, F W (Bauer, D J, and) Antiviral Chemotherapeutic Activity of Isatin β-thiosemicarbazone in Mice infected with Rabbit-pox Virus, 1496

Sheffield College of Technology Sandwich Course in Executive Development, 235

Shelby, J, and others The Inner Solar Corona during June 1959, 1308

Sheldon, Dr J C Polynuclear Complexes of Molybdenum (II), 1210

Shelesnyak, Prof M C, and others Carbonic Anhydrase in the Deciduoma of the Rat, 961

Shell Chemical Co, Ltd Certain operations to be integrated into three Divisions, 683

Shell and Siphon Regeneration in *Mactra stultorum* Linne (Lamellibranchiata), (L Birkett and R J Wood), 1075

Shelton, Dr Emma, and Rice, Dr Mary E Relation of Invasive Capacity to Passage of Lymphocytic Cells through Cellulose Membrane Filters, 479

Shepherd, Dr A A An Introduction to the Theory and Practice of Semiconductors, *review* by Dr R A Hyman, 1754

Shepherd, C J Structure and Chemistry of Proteins (Effect of Inhibitors of Protein Synthesis in *Aspergillus nidulans*), 1277

Shepherd, Dr L R Rocket Propulsion (Propulsion for Space Travel), 1266

Shepherd, Dr W M Appointed to the chair of theoretical mechanics in the University of Bristol, 322

Sheppard, N, and others Coal Science (Data obtained on Coal by High-resolution Magnetic Resonance Spectroscopy), 412

Sheppard, Dr P M Appointed reader in genetics in the University of Liverpool, 410

  Genetics and the Origin of Species, 587

Sheppard, Dr P M, and others Semi-Albino, a Third Sex-linked Allelomorph of Silver and Gold in the Fowl, 480

Sherins, Richard S, and others Tumour Specificity and Immunological Suppression, 563

Sherrard, Prof G O *Obituary* by Prof E Clarke and A Turner, 1531

Shibuya, Dr T (Takagi, Dr S F, and) 'On'- and 'Off'-Responses of the Olfactory Epithelium 60

Shielded Cells (Glove Boxes and), for Handling Radioactive Materials—a Record of the Proceedings of the Symposium on Glove Box Design and Operation held in the Cockcroft Hall, A E R E, Harwell, 1957 (edited by G N Walton), *review*, 1599

Shift in the Ultra-Violet Absorption Maxima and the Electronegativity of the Adjacent Atoms in some Aliphatic Carbonyl Compounds A Correlation between the (Dr P Borrell), 1932

Shigellae Transaminases in (Dr Ranjit Sen), 741

Shillito, J At the Conference of the Mammal Society of the British Isles (Population Structure, Ecology and Breeding of the Common Shrew under Wild Conditions), 29

Shimizu, Nobuo, and Morikawa, Nogaaki Histochemical Study of Monoamine Oxidase in the Developing Rat Brain, 650

Shimizu, Y (Nagata, T, and) Natural Remanent Magnetization of Pre-Cambrian Gneiss of Ongul Islands in the Antarctic, 1472

Shimura, Prof K (Sagisaka, S, and) Enzymic Reduction of α-Amino-adipic Acid by Yeast Enzyme, 1709

Ship *Savannah*, the First Atomic Merchant, B A 15

  The Nuclear-Powered, *Savannah* (F D Robinson), 677

Ship Hydrodynamics Laboratory, Feltham, 926

Shirley Institute Open Days at the, 1846

Shivas, Dr A A, and Fraser, Dr G P Lymphoid Necrosis Induced by Lipid Emulsions, 1813

Shock Waves Vibrational Relaxation and Dissociation of Carbon Dioxide behind (Dr I R Hurle and Dr A G Gaydon), 1858

Shockley, Dr W B Transistors and Associated Semiconductor Devices, 693

Shoelson, Seymour M, and others Staphylocoagulase Inhibition by Pooled Human Gamma-Globulin, 1665

Shoemaker, Dr James S, and Teskey, Dr Benjamin J E Tree Fruit Production, *review* by Prof H W Miles, 487

Shooter, Dr E M, and others A Haemoglobin with Unusual Alkaline-denaturation Properties in a Turkish-Cypriot Woman, 1876

Shoots of Cacao Plants Deficient in Copper Swellings on the (Dr R G Lockard, P Vamathevan and S Thamboo), 75

Shoots (Long), of *Ginkgo biloba* Vein Anastomoses in the Leaves of (Dr Howard J Arnott), 1336
Short, A M Decay of a Tau-Meson Underground, 893
Shorland, Dr F B (Hartman, L, and) Trans-Unsaturated Acids in the Depot Fat of Ruminants and Non-Ruminants 2024
Short, Dr R V Biosynthesis and Secretion of Adrenocortical Steroids (Biosynthesis and Secretion of Sex Hormones by the Adrenal Gland), 417
Short-tailed Shearwater *Puffinus tenuirostris* Experimental Demonstration of an Internal Rhythm of Reproduction in a Trans-Equatorial Migrant the (Dr A J Marshall and Dr D L Serventy) 1704
Shull, Prof H, and Hall, Dr G G Atomic Units, 1559
Shulzhenko, A I A Fossil Meteorite ?, 1026
Sickles, Grace M *Obituary*, 151
Sickness (Clover) Dagger Nematodes associated with a (F C Peacock), 123
Siddons, A W *Obituary* by W J Langford, 1684
Side-Chain Cleavage during the Reaction of Epinephrine and Norepinephrine with Ethylene Diamine Evidence of (Dr Louis-P Joly and Dr Guy Nadeau), 1483
Side-Chains (Propionate), of Haematin Decrease in Acid Strength of, on Reduction to Haem (Dr J E O'Hagan), 1808
Side-Chains (Tetrapyrrole) Selective Oxidation of (J Barrett and P Clezy), 1988
Siderosis (Splenic), in Mice treated with Dithiourethane (Prof P N Cowen), 366
Sidey (T K) (Summertime) Award of the Royal Society of New Zealand awarded to Dr J H Piddington, B A 16
Sie, Dr Hsien-Gieh, and others Liver Glucosyl Oligosaccharides and Glycogen—Carbon-14 Dioxide Experiments with Hydrocortisone, 1380
Siegbahn, K, and others Ionization Phenomena in Gases (Apparatus for the Electrode-less Generation and Acceleration of Plasma Rings), 1357
Siegel, S M (Goodman, N S, and) Reaction-directing Properties of Non-enzymic Macromolecules—Pyrogallol Oxidation in the System Iron (III)–Cellulose, 53
Sierra de Tamaulipas, Mexico Preliminary Archaeological Investigations in the (Dr Richard S MacNeish), 593
Sieve-Tube Sap Composition of (A J Peel and Dr P E Weatherley), 1955
Signal Contingent upon an Avoidance Response Effect of a (Prof J D Keehn and Sanniyah Nakkash), 566
Signals from Satellite 1958δ_2 (*Sputnik III*), (B G Pressey), 261
Signals (Radio), at Ionospheric Heights Refraction of Very High Frequency (S Weisbrod and L Colin), 119
Significance of Lactose in the Diet in Aminoaciduria caused by Maleic Acid (Stefan Angielski and Jerzy Rogulski), 276
Significance of the Time Relations of Humorally Co-ordinated Chromatic Responses (Dr A K Kent), 2027
Significance (Pleistocene Climatic), of Calcretes and Ferricretes (Dr R J Mason, A B A Brink and K Knight), 568
Sihtola, H Macromolecules (Starch and Cellulosic Chemistry), 1690
Sikorski, J Biological Fibres, B A 26
Silberman, Leo Air Surveys and the Social Scientist, 244
Silica (Fused and Crystalline) Structural Defects in (Dr W C Levengood), 1476
Silica Gel Colour Centres produced by Radiation in (Harold W Kohn), 630, *erratum*, 1026
Silicate System Measurement of Intergranular Diffusion in a—Iron in Forsterite (Prof John J Naughton and Yasuo Fujikawa), B A 54
Silicic Acid A Concave Concentration Gradient of Ethanol in Chloroform employed in Elution of Lipids from (J J Wren), 816
Silicon Carbide Semiconducting (Dr H K Henisch), 158
Silicon Resistor Use of the, in the d c Stabilization of Transistor Circuits (J T Zakrzewski and D H Mehrtens), 811
Silk, Dr M H, and Hawtrey, A O Possible Simplified Structure of Deoxyribonucleic Acid, 1484
Silver Atomic Weight of (E A C Crouch, E R Preece, I G Swainbank and A H Turnbull), 358
Ag, Au (Coinage Metals, Cu,) Electron Spin Resonance and Divalency of some Dithiocarbamates of the (Tore Vanngard and Stig Åkerstrom), 183
Silver Medals of the City of Paris awarded to I I Basilewsky for Prof Dimitri Panov, Isaac L Auerbach, Maurice V Wilkes, Adriaan van Wijngaarden, Hideo Yamashita, Alwin Walther, Aldo Ghizetti and Stig Comet, B A 16
Silver Staining Action of Ribonuclease on Nerve Axoplasm as Demonstrated by (R K Winkelmann and Robert W Schmit), 553
Silver and Gold in the Fowl Semi-Albino, a Third Sex-linked Allelomorph of (W F Werret, A J Candy, J O L King and Dr P M Sheppard), 480
Silverleaf, A Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 858, work of, 858
Silvers, Dr Willys K (Billingham, Dr Rupert E, and) The Structure of Science (Tissue Trnasplantation Antigen), B A 9
Sim, Dr G A, and others Crystal Structure of L-Serine Phosphate, 1863
Simey, Prof T S The Psychology of Social Class, *review*, 754
Simic, Marta M, and others Fate of the Highly Polymerized Spleen Deoxyribonucleic Acid labelled with Phosphorus-32 Injected Intraperitoneally into Rats, 1818
Simmonds, D H Structure and Chemistry of Proteins (Fractionation of Water-soluble Flour Proteins), 1277
Simmonds, R A (Gallagher, C H, and) Prophylaxis of Poisoning by Carbon Tetrachloride, 1407
Simmons, B A W (Jerrard, H G, and) Dielectric Studies on Deoxyribonucleic Acid, 1715
Simmons, I G Awarded a Nature Conservancy Research Studentship for post-graduate training in ecology (geography), 156
Simmons, Prof Jack New University, *review* by Sir John Wolfenden, 1975
Simmons's Citrate Agar Production of Colicines in (Dr J Papavassiliou), 1339
Simon, Dr Shirley E Ionic Partition and Fine Structure in Muscle, 1978
Simon Memorial Prize of the Low Temperature Group of the Physical Society awarded to Dr Heinz London, 1026
Simons, Dr J P Appointed Fellow in chemistry in the University of Birmingham, 1915
Simonsen, the late Sir John, and Ross, Dr W C J The Terpenes, Vol 5, The Triterpenes and their Derivatives, *review* by Prof A J Birch, 302
Simonsen, Dr M Awarded a grant by the Lady Tata Memorial Trust, for research on Leukaemia and allied Diseases, 507
Simple Carbohydrates Action of Manganese Dioxide on (Dr J L Bose, Dr A B Foster, Prof M Stacey and Dr J M Webber), 1301
Simple Observational Technique Value of a, for Determining the Fat Content of Algal Cells (Dr J H Evans), 1737
Simple Pathogenicity Test (A Rapid and), for Detecting Virulent Clones of *Fusarium oxysporum* f *cubense* using Seedlings of *Musa balbisiana* (Dr R H Stover), 1591
Simplified Method for the Culture of *Blatella germanica* under Aseptic Conditions (R B Clayton), 1166
Simplified Structure (Possible), of Deoxyribonucleic Acid (Dr M H Silk and A O Hawtrey), 1484
Simpson, D C, and others An Improved Technique for Intravenous Injection of Newborn Rats and Mice, 1952
Simpson, G G New Fossil Penguin from Australia, 1612
Simpson, George Gaylord (edited by Anne Roe and) Behavior and Evolution, *review* by Dr W H Thorpe, 1762
Sims, Dr L G A Appointed professor of electrical engineering in the University of Southampton, 590, work of, 590
Simulator for Research on Driver Behaviour (Prof J H Mathewson), 237
Simultaneous Change in both Differential and Interference Distances of Chiasmata (Dr J Yanney Wilson), 207
Sinclair, A N Behaviour of Sea Urchins, 783
Sinclair, D P (Thornton, R H, and) *Sporidesmium bakeri* and Facial Eczema of Sheep in the Field, 1327
Singapore Heterogeneity of Human Foetal Haemoglobin—Incidence of Foetal Variants in (Dr F Vella), 272
Singer, Dr Charles, and others (edited by) A History of Technology, Vol 5, The Late Nineteenth Century, *review* by Dr Leonard Carmichael, B A 5
Singer, Dr Ronald The Cape Town Science Exhibition 1959, 952
Singer, Dr Ronald, and others Haptoglobin and Transferring Variants in Bushmen and some other South African Peoples, 2042
Singer, Dr Thomas P (Kimura, Dr Tokuji, and) Functional Organization of the Respiratory Chain in Liver Mitochondria, 791
Single Bacteria Production of Colicine by (H Ozeki, Dr B A D Stocker and Helene de Margerie), 337
Single Bonds (Carbon–Carbon) Effect of Hybridization Changes on the Bond Energies of (J E Bloor and S Gartside), 1313
Single-Crystal Electron Diffraction Pattern Structure of Precipitated Cadmium Sulphide as studied by (Dr Ryoitiro Sato), 2005
Single Crystals (Polymer) Evidence for Distinct Sectors in (D C Bassett, Prof F C Frank and Dr A Keller), 810
Single Crystals (Zinc) Fatigue-Induced After-Effect in (A H Meleka and G B Dunn), 896
Single Living Cells Localization and Assay of Respiratory Enzymes in—Absorbancy Measurements on the *Nebenkern* (Dr Robert P Perry, Dr Bo Thorell, Dr Lennart Åkerman and Prof Britton Chance), 929, Fluorescence Measurements of Mitochondrial Pyridine Nucleotide in Aerobiosis and Anaerobiosis (Prof Britton Chance and Dr Bo Thorell), 931, Absorbancy Measurements on Liver and Kidney Cells (Dr Bo Thorell and Prof Britton Chance), 934
Single Nodes of Ranvier in Potassium-rich Solutions Action Potentials from (Dr Hans-Christoph Luttgau), 1494
Single Retinula Cell Response of a, to Polarized Light (M Kuwabara and K Naka), 455
Siniscalco, M, and others Haemoglobin Pattern of the Cyclostome *Petromyzon planeri* during the Course of Development, 1325
Sintered Alumina Transparent—'Lucalox' (General Electric Company of America), 1107
Sinton, W M Vegetation on Mars, 1612
Siphon Regeneration (Shell and), in *Mactra stultorum* Linne (Lamellibranchiata), (L Birkett and R J Wood), 1075
Sirek, Dr Anna (Sirek, Dr Otakar, and) A Low Concentration of certain Blood Constituents observed in Offspring of Alloxan-Diabetic Rabbits, 456
Sirek, Dr Otakar, and Sirek, Dr Anna A Low Concentration of certain Blood Constituents observed in Offspring of Alloxan-Diabetic Rabbits, 456
Sisefsky, J, and others Fractionation Phenomena in Nuclear Weapons Debris, 1771
Sisson, C H The Spirit of British Administration and some European Comparisons, 128
Sistrom, W R (Mathews, Micheline M, and) Function of Carotenoid Pigments in Non-Photosynthetic Bacteria, 1892
Site of Production of Œstrogen in the Ovary of the Rat (Dr Bengt Falck), 1082
Site and Season Influence of, on Agricultural Variety Trials (A. Sandison), 834
Siwalik System in India Indications of Glacierization in the (R C Mehridatta), 833
Six-Membered Heterocyclic Nitrogen Compounds with Three Condensed Rings (C F H Allen, in collaboration with G M Badger, Brice Graham, G A Reynolds, James H Richmond, John R Thirtle, J A van Allen and C V Wilson), *review* by Dr F G Mann, 216
Size of the Halogen Atom Influence of the, on the Difference between Lattice Constants of Copper dipyridine dichloride and dibromide (Vladimir Kupcik and Slavomil Durovic), 1060
Size of the Virus Particle Rotational Friction Coefficients of Models of Tobacco Mosaic Virus and the (Dr A J Haltner and Dr B H Zimm), 265
Size Distribution in *Velella* and *Physalia* Dimorphism and (Prof Robert Bieri), 1333
Skalba, Danuta, and others *Iso*-Antigens of Rabbit γ-Globulin, 1811
Skarzynski, Prof Boleslaw, and others Thiosulphate Metabolism in the Animal Organism, 994
Skatshokova, X, and others Agar Electrophoresis of Normal Soluble Proteins in Guinea Pig Liver, B A 64
Skeletal Formation in the Chick Embryo Inhibition of, following Administration of Tetracycline (Gerrit Bevelander, Hiroshi Nakahara and Gloria K Rolle), 728

Skeletal Muscle Mitochondria (Human) Enzymic Activities of—a Tool in Clinical Metabolic Research (Dr L Ernster, Dr D Ikkos and Dr R Luft), 1851
Skellam, J G Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 859 , work of, 859
Skills New Developments in Training—Five Studies in the Efficient Communication of (edited by Frank A Heller), 421
Skin Homografts Tolerance to, of Adult Mice after Parabiosis (Dr B A Rubin), 205
Skin Homografts in Parabiotic Mice (Anna Skowron-Cendrzak and Barbara Konieczna-Marczynska), 1590
Skinner, B , and others Ionization Phenomena in Gases (Theoretical Calculation of the 1s–2p Electron Excitation Cross-section of Atomic Hydrogen), 1354
Skinner, Dr H A Thermodynamics (Experimental Thermochemistry), 1607
Skinner, Dr H A , and others Developments in Thermodynamics, 1606
Skornyakov, Prof G Nuclear Forces and the Few-Nucleon Problem (Binding Energies and Elastic Scattering of Light Nuclei at Low Energies—*n–d* Scattering in the Zero-range Force Approximation), 1114
Skowron-Cendrzak, Anna, and Konieczna-Marczynska, Barbara Skin Homografts in Parabiotic Mice, 1590
Skull (A New Fossil), from Olduvai (Dr L S B Leakey), 491
Skull and Jaw (Piltdown) Radiocarbon Dating of the (Prof H de Vries and Dr K P Oakley), 224
Skunks (Spotted), of the Genus *Spilogale* A Taxonomic Revision of the (R G Van Gelder), 1024
Sky Matter, Earth and (Prof George Gamow), *review* by G R Noakes, 214
  The Night, in October, 508 , in November, 772 , in December, 1451 , in January, 1915
Sky Wave Field Strength in Tropical Regions The Calculation of the Median (W R Piggott), 605
Sladden, Dr C R Appointed lecturer in biology at the University of Birmingham, 1026, 1362
Slater, Dr E Biological Problems arising from the Control of Pests and Diseases (Genetics of Mental Disease), 1102
Slater, Prof E C Enzymes, 687
  Steric Aspects of the Chemistry and Biochemistry of Natural Products (Oxidation-reduction Enzymes), 949
Slater, Prof E C (Borst, P , and) Need for Inorganic Phosphate in Oxidations stimulated by Dinitrophenol, 1396
Sles, I S The Mongolian Wild Horse, *Equus przewalskii*, 1024
Slices of Liver Synthesis of Diphosphopyridine Nucleotide from Nicotinamide by (C J Threlfall), 60
Slices (Tissue) Application of Warburg's Equation to (Dr I S Longmuir and Dr Ann Bourke), 634
Sliding Filament Contractile Mechanism in Tonic Smooth Muscles of Lamellibranch Molluscs Evidence for a (Dr Jean Hanson and Dr J Lowy), 286
Slifer, Prof Eleanor H Survival of Grasshopper Eggs kept for Long Periods in Mineral Oil, 1424
Slikke, L B v d , and others Intravascular and Intracardiac Blood Velocity Patterns recorded by means of *NTC* Resistors, 991
Slime from Tomato and Banana Strains of *Pseudomonas solanacearum* Comparison of (Dr W F Dudman), 1969
Slime Molds The Cellular (Prof John Tyler Bonner), *review* by D Park, 1976
Sloan Foundation (Alfred P) Appointment of Dr Warren Weaver as vice-president, 23,
Slonimski, P Cytoplasmic Inheritance (Determination of Specificities of Respiratory Enzymes), 1012
Slot, G From Microphone to Ear, second edition, *review* by Prof Colin Cherry, 841
Slow-Drift Solar Radio Bursts Geomagnetic Disturbance and Velocity of (M B Wood and C S Warwick), 1471
Small Percentages of Foetal Haemoglobin Estimation of (Prof K Betke, H R Marti and I Schlicht), 1877
Smart, Prof W M Retirement as regius professor of astronomy in the University of Glasgow, 23 , work of, 23
Smears Fluorescent Schiff-Type Reagents for Cytochemical Detection of Polyaldehyde Moieties in Sections and (Prof Frederick H Kasten, Vivian Burton and Peggy Glover), 1797
Smelt, R , and others Jets and Rockets, *review* by D G King-Hele 1346
Smets, G J Macromolecules (Application of Classical Organic Reactions to Vinyl Polymers), 1690
Smidt, J , and van Krevelen, D W Coal Science (Spectroscopy of Coals—Electron Magnetic Resonance Spectroscopy to study Coals in Course of Carbonization under Vacuum), 413
  Number of Free Radicals in Coal during Carbonization at Different Heating Rates, 719
Smilax kraussiana Pachytene in *Puccinia kraussiana* Cooke, on (Dr Eva Sansome), 1820
Smit, C , and others Ionization Phenomena in Gases (Optical Excitation Functions in experiments with Mercury and Helium), 1354
Smith, Dr A C Self-Regulation in Living Systems (Analysis of the Properties of Idealized Control Systems, suing the Method of the Laplace Transformation), 239
Smith, A D , and others Radioprotective Action of Methoxamine, 1729
Smith, A D (Ashwood-Smith, M J , and) Rat Brain Glutathione and Pyridoxine Deficiency, 2028
Smith, B S Appointed lecturer in civil engineering at the University of Bristol, 1613
Smith, B V Kingsley, and Lacy, Dr D Residual Bodies of Seminiferous Tubules of the Rat, 249
Smith, C L , and others Deoxyribonucleic Acid Formation in Multiplying HeLa Cells, 107
Smith, D E (May, B R , and) The Continued Progress of Satellite 1958δ_2 (*Sputnik III*), 765
Smith, Sir Ewart The Critical Importance of Transport and Communications (Presidential Address to Section G (Engineering) of the British Association for the Advancement of Science), B A 44
Smith, Prof F , and others Possible Role of Glycerol in the Winter-Hardiness of Insects, 288
Smith, G , and others Detection of Thyroid Antibodies using Bentonite Particles, 478
Smith, Dr G F Herbert Gemstones, thirteenth edition revised by Dr F Coles Phillips, *review* by Dr W Campbell Smith, 1008
Smith, Dr I R Appointed lecturer in electrical engineering at the University of Birmingham, 684, 1362
Smith, Dr J A (Porter, Prof G , and) Mechanism of Atom Recombination, 446
Smith, Dr J A , and others Ionization Phenomena in Gases (Optical Excitation Functions in experiments with Mercury and Helium) 1354
Smith, J E W L , and others Crystallographic Studies of the Biuret Reaction, 707
Smith, J F Appointed reader in morbid anatomy at University College Hospital Medical School, London, 322
Smith, J G M , and others Preparation of Crystalline *trans-trans* Methyl Linoleate Hydroperoxide, 816
Smith, J M Thermodynamics (Phase Changes in Condensed Systems), 1609
Smith, J Maynard Genetic Analysis, *review*, 752
  A Theory of Ageing, 956
Smith, J W (Greenhow, E J , and) Coal Science (Chemical Reactions of Coal), 413
Smith, Dr Kenneth M Recent Work on the Electron Microscopy of Viruses, 1440
Smith, Dr Kenneth M , and others A Suspected Virus Disease of the Citrus Red Mite *Panonychus citri* (McG), 70
Smith, Dr Kenneth M , and Lauffer, Max A (edited by) Advances in Virus Research, Vol 6 *review* by N W Pirie, 920
Smith, L B Origin and Dispersal of Flowering Plants (Flora of south Brazil had its greatest source in central Brazil), 1201
Smith, L H (St Amand, Prof W , and) Interstrain Ovarian Transplantation in Lethally Irradiated Mice after Bone Marrow Therapy, 1503
Smith, jun , Dr Lloyd H , and others Distribution of 5-Carboxymethylhydantoinase, 1314
Smith, Madeleine Blood Grouping of the Remains of Swedenborg, 867
  The Future of the Etruscans, *review*, 1348
Smith, Piroska (*nee* Vermes), and Sproule, D O Experiments on the Acousto-Electric Effect, 264
Smith, Prof Paul K Acetophenetidin, *review* by Dr Marthe Vogt, 1349
Smith, Ray F (edited by Edward A Steinhaus and) Annual Review of Entomology, Vol 4, *review* by Dr P T Haskell, 489
Smith, Dr R H Absorption of Magnesium in the Large Intestine of the Calf, 821
Smith, Dr Sydney Animal Clocks, 765
Smith, Dr Wray Appointed assistant director of the Willow Run Laboratories in the University of Michigan, 26
Smith, Dr W Campbell, Gemmology, *review*, 1008
Smith, Dr W G Mast Cell Population of Lung of the Guinea Pig and other Tissues, 1154
Smith, Kline and French Research Institute Grant of £1,500 to the University of Oxford, for research on the electrophysiology and pharmacology of smooth muscle, 1362
Smith-Rose, Dr R L *Obituary* of Dr B van der Pol, 1020
  Obituary of Prof J Zenneck, 1188
Smithsonian Institution List of Publications available on June 30, 1958 (compiled by Eileen M McCarthy), 95
  Miscellaneous Collections, Vol 135, No 1, The Customs and Religion of the Ch'iang (D C Graham), B A 15
  Miscellaneous Collections, Vol 137, Studies in Invertebrate Morphology, in honor of Dr Robert Evans Snodgrass on the occasion of his eighty-fourth Birthday, 591
  Report for 1957-58, B A. 26
Smoke (Tobacco) Composition of Paraffin Wax Fraction from Tobacco Leaf and (Dr R Carruthers and Dr R A W Johnstone), 1131
Smoke Emission from Coal and Low-Temperature Chars (Studies of Coal), (D Finch), 426
Smolin, Edwin M , and Rapoport, Lorence (edited by) *s*-Triazines and Derivatives (The Chemistry of Heterocyclic Compounds, Vol 13), *review* by Dr F G Mann, 1758
Smolt Stages (Parr and), of the Atlantic Salmon Sodium Regulation in the Blood of (Prof H J Koch, J C Evans and E Bergstrom), 283
Smooth Muscles (Tonic), of Lamellibranch Molluscs Evidence for a Sliding Filament Contractile Mechanism in (Dr Jean Hanson and Dr L Lowy), 286
Smorodintsev, Prof A A , and others Statement on Biological and Chemical Warfare, 1018
Smy, P Thermonuclear Research (Shock Waves in Gases), 1017
Smyth, E H J Biomechanics (Functional Significance of the Formation of Trabeculae in the Neck of the Femur), 513
Snail, *Limnaea truncatula* Penetration of the Liver-fluke, *Fasciola hepatica*, into the (Dr Ben Dawes), 1334
Snedden, W (Reed, R I , and) Coal Science (Spectroscopy of Coals—Fragments produced from Aromatic Compounds), 413
Snell, A H Ionization Phenomena in Gases (Present State of the *DCX* Experiment), 1356
Snell, Dr Cornelia T (Snell, Dr Foster Dee and, assisted by Snell, Dr Chester Arthur) Colorimetric Methods of Analysis, including Photometric Methods Vol 2A, *review* by J King, 1522
Snell, Dr Foster Dee, and Snell, Dr Cornelia T , assisted by Snell, Dr Chester Arthur Colorimetric Methods of Analysis, including Photometric Methods, Vol 2A, *review* by J King, 1522
Snodgrass, Dr Robert Evans Studies in Invertebrate Morphology, in honor of, on the occasion of his eighty-fourth Birthday (Smithsonian Institution, Miscellaneous Collections Vol 137), 591
Snow, Sir Charles The Two Cultures and the Scientific Revolution (Rede Lecture, 1959), 295, 411
Snow Samples (Antarctic) Oxygen Isotope Variations in (Dr R Gonfiantini and Prof E Picciotto), 1557
Snyder, Dr Conway W The Upper Boundary of the Van Allen Radiation Belts, 439
Sobey, A J Structural Effects of Kinetic Heating (The Advantages and Limitations of the Use of Models), 31
Social Class The Psychology of (Maurice Halbwachs), translated by Claire Delavenay, *review* by Prof T S Simey, 754
Social Evolution in Man Main Stages of (Dr Max Pettersson), 481

Social Groupings in Fishes Studies on (Dr C M Breder, Jr), 865
Social Scientist Air Surveys and the (Leo Silberman), 244
Societe Française de Metallurgie Journees Metallurgiques d'Automne (Les Gas dans les Metaux), 95
Societe Française de Metallurgie (Non-Destructive Testing Group of the Institute of Physics and the) Discussion on the Relationship between Structure and Physical Properties of Materials, 1688
Societies (Learned and Professional), in Britain Taxation of, 1343
Society Automation and (edited by Howard Boone Jacobson and Joseph S Roucek), *review* by R Brightman, 1438
  Role of the Scholar in (Dr Henry Allen Moe), 7
  Science and, 127
Soczewinski, Edward (Waksmundzki, Andrzej, and) A Paper-Chromatographic Method for the Determination of Suitable Buffer Systems for Countercurrent Distribution, 977
Soddy, Frederick Pioneer Research on the Atom, the Life Story of (Muriel Howorth), *review* by Prof Norman Feather, 298
Sodium Distribution of, in Compact Bone, as revealed by Autoradiography of Neutron-activated Sections (Prof J Vincent), 1332
  Ultrasonically Dispersed (M W T Pratt and R Helsby), 1694
Sodium Carrier Evidence for Phosphatidic Acid as the (Dr Lowell E Hokin and Mabel R Hokin), 1068
Sodium Chloride Intake and Urinary Histamine in Adrenalectomized Rats (Dr T Bjuro and Dr H Westling), 1241
Sodium Concentration (Elevated Plasma) Effects of, on Sodium and Potassium in the Erythrocyte of the Lizard *Trachysaurus rugosus* (Gray), (P J Bentley), 1403
Sodium Regulation in the Blood of Parr and Smolt Stages of the Atlantic Salmon (Prof H J Koch, J C Evans and E Bergstrom), 283
Sodium Sulphosuccinate (Dioctyl) Registration of the Spermicidal Effects of (Prof Per Eric Lindahl and Kjell Wedin), 1289
NaH^{14}CO$_3$ to Haem Pathway of Carbon-^{14} Incorporation from, in Duck Blood Incubated *in vitro* (A Breccia, A L Fantola, E Lazzarini and A Giustina), 1879
Sodium-free Hydrazinium Solution Excitability and Phosphorylation of Muscle and Nerve in (L G Abood and K Koketsu), 725
Sodium and Potassium Glass Micro-Electrodes for Measuring Intracellular Activities of (Dr J A M Hinke), 1257
Sodium and Potassium in the Erythrocyte of the Lizard *Trachysaurus rugosus* (Gray) Effects of Elevated Plasma Sodium Concentration on (P J Bentley), 1403
Soft Sea-bottom in Arctic North America The Benthos of (Dr D V Ellis), B A 79
Soil Effect of the Level of Microbial Population on Isotopically Exchangeable Phosphate in (Dr P Newbould and Dr R L Lucas), 1155
  Isolation of Basidiomycetes from the (J H Warcup), 506
  Nitrogen Replenishment in the (Dr N R Dhar), 942
Soil of the Nigerian Rain-Forest Zone Non-Symbiotic Nitrogen Fixation in a (Dr A W Moore and J N Abaelu), 75
Soil (Podzol) Oxygen-containing Functional Groups in the Organic Matter of a (J R Wright and J Schnitzer), 1462
Soil (Uganda Swamp) Nitrogen Fixation in a (E A Calder) 746
Soil Block Test Method for Timber Limitations Imposed by some Water-borne Preservatives on the (A J McQuire), 1430
Soil Chemical Analysis (Prof M L Jackson), *review* by J M Bremner, 1093
Soil Cultures (Agar and) Translocation of Cobalt-60 and Caesium-137 by Fungi in (Dr Erna Grossbard and Dr D R Stranks), 310
Soil Fertility (Low) Adaptation of a Lead-tolerant Population of *Agrostis tenuis* to (D Jowett), 43
Soil Fungi in the Belgian Congo, 236
Soil Insecticide and Nematicide Formulations Effect of Emulsifiers and Organic Diluents in (F T Phillips), 1512
Soil Micro-Organisms Factors in Forest-Tree Litter Extracts affecting the Growth of (Dr Roger Knowles and Edward Laishley), 1169
Soil Organic Matter Titration Curves of (R S Beckwith), 745
Soil Salinity Course in Tunisia (Prof W R van Wijk), 1778
Soil Science Mineralogical Aspects of (Welsh Soils Discussion Group Discussion on), 156
Soil Science, British Society of Discussion on Availability of Plant Nutrients, 159
Soil Science, Indian Society of Presidential Address (Dr N R Dhar), 942
Soil Survey of Great Britain (England and Wales) Memoirs of the, The County of Anglesey—Soils and Agriculture (E Roberts), (Agricultural Research Council), 154
Soil and Land-Use Surveys of the Regional Research Centre of the British Caribbean No 1, Parish of St Catherine, Jamaica (K C Vernon), No 2, The Rupununi Savannas of British Guiana (R F Loxton, G K Rutherford and J Spector), No 3, St Vincent (J P Watson J Spector and T A Jones), 27
Soils Occurrence of Microbiological Filaments in (Roy D Bond), 744
Soils in the Kongwa and Nachingwea Districts of Tanganyika A Survey of (B Anderson), *review* by Dr R M S Perrin, 1901
Soils of Tanganyika, *review* by Dr R M S Perrin, 1901
Soils Discussion Group, Welsh Discussion on Mineralogical Aspects of Soil Science, 156
Soils (Salt-affected) Diagnosis, Improvement and Management of (Unesco Middle East Science Co-operation Office Regional Training Course on), 1778
Sokol, F, and others Infectious Ribonucleic Acid from Mouse Brains infected with Tick-borne Encephalitis Virus, 1581
Sol Moississures du, et des Litieres de la Region de Yamgambi (J Meyer), 236
Solanum nigrum L A 40-Chromosome Variant in (U K Rai), 1587
Solar Activity (Secular) Changes in the Climate of the Atlantic–European Area and (Z Gregor and L Křivsky), 682
Solar Corona Kellogg and Ney's Model of the (Dr D E Blackwell and Dr D W Dewhirst), 1120, (Prof Edward P Ney and Prof Paul J Kellogg), 1122
Solar Corona (The Inner), during June 1959 (G A Newkirk, G W Curtis, D K Watson, R Manning and J Shelby), 1308
Solar Corpuscular Clouds Apparent Observation of, by Direct Continuous-Wave Reflexion (Dr John D Klaus and W Reed Crone), 965
Solar Cosmic Rays Satellite Observations of (Pamela Rothwell and Carl McIlwain), 138
Solar Disk Distribution of Flares on the, Associated with Noise (L R McNarry), 806
Solar Effects in the Motion of *Vanguard* (Dr Stanley P Wyatt), 351
Solar Energy Transactions of the International Conference on the Use of—The Scientific Basis (Tucson, 1955), Vol 1, The Available Energy, Measurement of Radiation, Vol 2, Thermal Processes, Part 1, Section A, Flat Plate Collectors, Vol 2, Thermal Processes, Part 1, Section B, High-Temperature Solar Furnaces, Solar Power, Vol 3, Thermal Processes, Part 2, Solar House Heating, Solar Water Heating, Solar Stoves, Solar Distillation, Vol 4, Photochemical Processes, Vol 5, Electrical Processes, *review* by Dr H Heywood, 217
Solar Flare Magnetic Field associated with a Great (Dr Robert Howard, Dr Thomas Cragg and Dr Horace W Babcock), 351
Solar Flares Association of Radio Outbursts with (L D de Feiter, A D Fokker and J Roosen), 805
  Rocket Studies of Emissions caused by (United States National Science Foundation Grant), 406
Solar Radio Bursts (Slow-Drift) Geomagnetic Disturbance and Velocity of (M B Wood and C S Warwick), 1471
Solar Radio Radiation (Enhanced) Observations of the Fine Structure of, with a Narrow-Band Spectrum Analyser (Oystein Elgaroy), 887
Solar Wind The Aurora, the Radiation Belt and the—a Unifying Hypothesis (M H Rees and G C Reid), 539
Solid Chromatography (Gas) Separation of the *Meta-* and *Para-*Isomers of the Xylenes, Cresols and Toluidines by (M A Hughes, D White and Prof A L Roberts), 1796
Solid Solutions (Dilute Binary), of Bismuth in Tellurium and Tellurium in Bismuth Some Semiconductive Properties of (Dr Tomasz R Piwkowski), 355
Solid State Disorganization of the Secondary Structure in Proteins exposed to Ionizing Radiations in the (Dr Peter Alexander, L D G Hamilton and Dr K A Stacey), 226
Solid State Physics (Australian Branch of the Institute of Physics Conference on), 1117
Solid State Physics (edited by Frederick Seitz and David Turnbull), Vols 4, 5 and 6, *review* by Prof E C Stoner, 1753
  Aspects of, *review* by Prof E C Stoner, 1753
Solid State Rheological Study of the Mechanism of Paraffin-Detergent Interactions in Aqueous Systems (F J Radd and L H Crowder), 443
Solidago Chromosome Numbers in (J R Beaudry and D L Chabot), 236
Solids Electron–Phonon Interaction in (Physical Society Conference on), 1613
  Explosions in, *review* by Dr Peter Gray, 664
  Fast Reactions in (Dr F P Bowden and A D Yoffe), *review* by Dr Peter Gray, 664
  Influence of Crystal Defects on the Szilard-Chalmers Process in (Dr A G Maddock and J I Vargas), 1931
Solids such as Metals A Theory of the Abrasion of (J Goddard, H J Harker and H Wilman), 333
Solids (Liquids and) Molecular and Atomic Motions in, by Radiofrequency Methods (Colloque AMPERE and the Radiofrequency Spectroscopy Group Joint Discussion on), 157
Soliman, Dr F A The Anterior Pituitary-like Activity of Rumen Contents, 1723
Solomon, I Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Sols et de la Vegetation du Congo Belge et du Ruanda-Urundi Carte des—6, Yangambi Planchette 3, Lilanda, A Sols, B, Vegetation (Notice explicative par P Gilson, P Jongen, A Van Wambeke et L Liben), (Institut National pour l'Etude Agronomique du Congo Belge), 27
Soltys, Dr M A The International Veterinary Congress, 598
Solubility of Water in Hydrocarbons Use of Tritium to Study the (B D Caddock and P L Davies), 2011
Solubility (Urea-Bisulphite) Permanent Set, Supercontraction and—the Proton-Transfer Nature of some Changes in Keratin and the Analogy with Muscle Contraction (Dr P T Speakman), 339
Solubility Data (Mutual) Estimation of the Interchange Energy for Binary Systems from (Kiyoharu Ishida), 814
Soluble Derivatives Extraction of the Total Protein from Wheaten Flour in the Form of (E E McDermott and Dr J Pace), 546
Soluble Proteins (Normal), in Guinea Pig Liver Agar Electrophoresis of (Prof Iv Goranov, Y Todorov, X Skatshokova, M Hlebarova and P Kuzmanova), B A 64
Solution Concentration of Stearic Acid in Monolayers Adsorbed from (George L Gaines, jun), 1139
  Fast Chemical Reactions in (Deutsche Bunsengesellschaft fur Physikalische Chemie and the Max-Planck Gesellschaft Colloquium on), 1453
  Influence of Counterion Association on the Configuration Stability of Deoxyribonucleic Acid in (F Ascoli, C Botre, V Crescenzi, A Mele and Prof A M Liquori), 1482
  Secondary Structure of Ribonucleic Acid in (Dr R A Cox and Dr U Z Littauer), 818
Solution (A Least-Squares), for a Linear Relation between Two Observed Quantities (P A Wayman), 77, (B K Kelly), 1086
Solution (Sodium-free Hydrazinium) Excitability and Phosphorylation of Muscle and Nerve in (L G Abood and K Koketsu), 725
Solutions (Concentrated Urea) Effect of, on the Infectivity and Haemagglutinin of Vaccinia Virus (Prof J F McCrea and Jean O'Loughlin), 1497
Solutions (Dilute Binary Solid), of Bismuth in Tellurium and Tellurium in Bismuth Some Semiconductive Properties of (Dr Tomasz R Piwkowski), 355
Solutions (Irradiated) Aromatic Ring Opening in the Presence of Oxygen in (Israel Loeff and Gabriel Stein), 901
Solutions (Potassium-rich) Action Potentials from Single Nodes of Ranvier in (Dr Hans-Christoph Luttgau), 1494
Solutions (Streptomycin) Influence of, on the Interaction between the Agglutinating Sera and the Corresponding Red Blood Cell Receptors (Dr M Kout and Dr Z Kubickova), 639
Solvents (Mixed) Action of, on Wool (J C Atkinson, A Filson and Prof J B Speakman), 444
Solyankin, Dr E V Polar Front Survey (Hydrography—Greenland and Norwegian Seas), 1181
Solymosy, Dr F, and others Biochemical Mechanism of Lesion Formation in Virus-infected Plant Tissues, 706
Somers, Dr E Fungitoxicity of Metal Ions, 475

Sommerfelt, Alf A Elected an Honorary Member of the American Academy of Arts and Sciences, 410
Sonneborn T M Cytoplasmic Inheritance (Kappa and Paramecin), 1012
Sorbaeva, N A, and others Rate of Appearance of Mutants with Respiration-deficiency in *Staphylococci*, 1821
Sorbitol Effect of, on the Urinary Excretion of some B Vitamins in Man (J D Watson and Prof John Yudkin), 911, *errata*, 1362
Sorbitol in Rats and Mice Thiamine-sparing Action of (Dr T B Morgan and Prof John Yudkin), 909
Sorensen, Ole, and others Some Enzymatic Properties of Suspensions of Parenchymatous Liver Cells, 1400
Sorghum Resistance of, to Witchweed (C N Williams), 1511
Sorokin, Dr Constantine Tabular Comparative Data for the Low- and High-Temperature Strains of *Chlorella*, 613
Sorvall, Inc, Ivan Super-speed Servall SS-3 Automatic Centrifuge, 322
  SS-4 Enclosed Centrifuge, 322
Soule, J L, and Durif, S Coal Science (Ultra-fine Structure of Coals and Chars—Coals of Pores of Sizes 22-25A), 413
Soulsby, Dr E J L *Obituary* of Dr D O Morgan, 1684
Sound Velocity of, in Relaxing Gases (H J Wintle), 2007
Sour and Sweet Cherries Occurrence of Leuco-Anthocyanin in (Dr Kuang C Li), 1935
Source of Air-borne Nitrogenous Material and other Plant Nutrients Surface of the Ocean as a (Dr A T Wilson) 99
Source of Protein for Cultivation of HeLa Cells Discarded Blood Bank Blood as a (Billy R Blakey and Prof George E Gifford), 1158
Source Book of Fungal Physiology, *review* by Dr J L Harley, 85
South Africa, Advisory Council on Scientific Policy of the Union of First and Second Annual Reports, 1191
South African Animal Life—Results of the Lund University Expedition in 1950-51, Vol 5 (edited by Bertil Hanstrom, Per Brinck and Gustaf Rudebeck), *review*, 133
South African Association for the Advancement of Science (Cape Council), and the Royal Society of South Africa, Second Science Exhibition, 952
South African Council for Scientific and Industrial Research Thirteenth Annual Report (1957-58), 1449
South African Peoples Haptoglobin and Transferrin Variants in Bushmen and some other (Dr N A Barnicot, J P Garlick, Ronald Singer and Dr J S Weiner), 2042
South America Transport of Driftwood from, to Tasmania and Macquarie Island (Prof H N Barber, Dr H E Dadswell and H D Ingle), 203
South American Indians Frequency of the New Blood Group Antigen Js among (Dr Miguel Layrisse and Dr Zulay de Layrisse), 640
South Equatorial Countercurrent in the Pacific Ocean Evidence of a (Joseph L Reid, jun), 209
South Pole Geodetic Marker at the (To be erected by the United States Coast and Geodetic Survey), 1612
South-western Australia Precambrian Geology of (A F Wilson), 237
Southern, H N (Hook, O, and) At the Conference of the Mammal Society of the British Isles (Erosion caused by Hippopotami in Uganda), 30
Southern Africa Eels in (R A Jubb), 827
Southern Rhodesia *Haematopota insidiatrix* Austen (Diptera, Tabanidae), in (Dr Robert Barrass), 739
Southern Root Knot Nematode A Virus Disease of *Meloidogyne incognita incognita*, the (J R Loewenberg, T Sullivan and M L Schuster), 1896
Southwood, Dr T R E, and Leston, Dennis Lanf and Water Bugs of the British Isles, *review* by W J Le Quesne, 1977
Soviet Encyclopaedia Large (Bolshaya Sovietskaya Enziclopediya), Vol 50, 857, 1451
Soviet Ministry of Culture (British Council and the) Exhibition in Moscow of British Books and Periodicals, 1361
Soviet Pharmaceutical Research Vol 1, Pharmaceutical Chemistry, Vol 2, Pharmacognosy, Vol 3, Medicinal Chemistry, *review* by Dr D Train, 1831
Soviet Rubber Technology Title of an English translation of *Kauchuk i Rezina*, to be published by the Research Association of British Rubber Manufacturers, 505
Soviet Scientific Information Providing United States Scientists with (United States National Science Foundation), revised edition, 1611
Soviet Slavic Studies (published in the Russian language by the Academy of Sciences of the U S S R), 410
Soviet Technology, Digest of, No 1 (Engineering Information Services, Ltd), 320
Soviet Union Recent Work in the, in the field of Seismology (Committee on Geodesy and Geophysics of the Academy of Sciences of the U S S R Report on), 322
Soviet and United States Scientists Exchanges between, 680
Soya Bean Plants Translocation of Carbon-14-labelled Amino-Acids and Amides in the Stems of young (C D Nelson and P R Gorham), 855
Soya Extracts A Lipoperoxidase Factor in (Dr John A Blain and Edward C C Styles), 1141
Soybean Nobules during the Vegetative Period Redox Potentials in (Dr Helena Ebertova), 1046
Space Change of Cosmic Rays in (Prof H V Neher), 423
  The Threshold of—the Proceedings of the Conference on Chemical Aeronomy, sponsored by the Geophysics Research Directorate, Air Force Cambridge Research Center, Cambridge, Mass, 1956 (edited by M Zelikoff), *review*, 1011
Space (Visual) Possible Role of Higher Proprioceptive Centres in the Perception of, and in the Control of Motor Behaviour (Dr B Gurevitch), 1219
Space Flight Russian View of, *review* by D G King-Hele, 836
Space Projectiles launched in the Soviet Union (Articles in *Priroda* dealing with), 771
Space Research British, 24
  Prelude to, *review* by D G King-Hele, 663
Space Research, Canadian Committee on, 24
Space Rocket The Second Russian, 406
  The Third Russian (Earth Satellite 1959θ), 852
Spaced Observations of Radio Noise from the Outer Atmosphere (G R A Ellis, D G Cartwright and J R V Groves), 1391
Spacings (Lattice), and Structures of Metals and Alloys A Handbook of (Dr W B Pearson), *review* by Dr J A Catterall, 841
Sparagmites (Norwegian), and the Late Pre-Cambrian Ice Age Palaeomagnetism in some (W B Harland and D E T Bidgood), 1860
Sparling, L G M Appointed lecturer in mechanical engineering at the University of Sheffield, 1451
Spatial Detail Vision Measurements of Temporal Adaptation to (A J Seyler and Z L Budrikis), 1215
Spatial and Temporal Summation Visual (Dr Ernest Baumgardt), 1951
Spawning of *Hydractinia echinata* Effect of Acetylcholine and Eserine on the (M Yoshida), 1151
Spawning Quinnat Salmon Stomach Contents of (J S Bullivant), 71
Speakman, Dr H B Report of the Director of the Ontario Research Foundation for 1958, 865
Speakman, Prof J B and others Action of Mixed Solvents on Wool, 444
Speakman, Dr P T Permanent Set, Supercontraction and Urea-Bisulphite Solubility—The Proton-Transfer Nature of some Changes in Keratin and the Analogy with Muscle Contraction, 339
Special Ceramics (British Ceramic Research Association Symposium on), 1115
Special Relativity A New Experimental Test of (J P Cedarholm and Prof C H Townes), 1350
Speciation among Lampreys (Dr Giuseppe Zanandrea), 380
Species Genetics and the Origin of (British Association for the Advancement of Science, Sections D (Zoology) and K (Botany), Symposium on), 587
  The Young Darwin and the, 'Origin of (Prof C F A Pantin), 1533
Species of *Eriophyses* Floral Malformation in *Panicum antidotale* caused by a (Dr V M Desai and Dr M J Thirumalachar), 1586
Species of *Fusarium* Production of Emetic Material by (Neville Prentice, A D Dickson and Prof J G Dickson), 1319
Species Specificity of Fish Mucus (J M Barry and Prof Fergus J O'Rourke), 2039
Species (Living) The Evolution of (Royal Society of Victoria Symposium on), 156
Specific Bacteriophages (Some New), for Plant Pathogenic *Xanthomonas* spp (Z Klement), 1248
Specific Infection of Mice Immunization with Biologically Active Fractions of Deoxyribonucleic Acid and Subsequent (Dr M Kohoutova), 1965
Specific Inhibition of Antibody Formation during Immunological Paralysis and Unresponsiveness (Dr E Sercarz and Dr A H Coons), 1080
Specific Inhibition of Anti-Rh Serum by 'Unnatural' Sugars (Dr William C Boyd, Marjorie H McMaster and Eugenia Waszczenko-Zacharczenko), 989
Specific Response in the Hippocampus of the Rabbit to Olfactory Stimulation (B G Cragg), 1697
Specific Surface of a Powder Rapid Estimation of the (Dr H E Rose and R M E Sullivan), 46
Specific and Sensitive Assay Method for Vasopressin and Oxytocin using Glass-Paper Chromatography (Akira Arimura and Prof Joseph F Dingman), 1874
Specificity in Protein Biogenesis (Centre Interuniversitaire de Recherches enzymologiques Colloquium on), 1198
Specificity of the Tryptophan Peroxidase-Oxidase Enzyme System (Dr R H Marchant), 1711
Specificity (Species), of Fish Mucus (J M Barry and Prof Fergus J O'Rourke), 2039
Specificity (Tumour), and Immunological Suppression (Elaine Levi, A M Schechtman, Richard S Sherins and Stanley Tobias), 563
Spector, J, and others Soil and Land-Use Surveys of the Regional Research Centre of the British Caribbean, No 2, The Rupununi Savannas of British Guiana, No 3, St Vincent, 27
Spectra (Atomic) Collision Effects in (W R Hindmarsh), 155
Spectra (Infra-Red), of Carbohydrate Sulphate Esters (Dr A G Lloyd and K S Dodgson), 548
Spectra (Very Low-Frequency), of Atmospherics propagated through the Ionosphere (Tatsuzo Obayashi), 34
Spectra (Visible Absorption), of Copper-ethylene-diamine-*bis* (acetylacetone) in the Crystalline State (Animesh Chakravorty and Dr Sadhan Basu), 50
Spectral Composition of the Luminescence of the Euphausiid *Thysanoessa raschii* (Dr Brian P Boden and Dr Elizabeth M Kampa), 1321
Spectral Lines Collision Broadening of, 155
Spectrofluorimetry Photolysis of Thionine in Rigid Medium—Measurement by (Dr C A Parker and W T Rees), 1223
Spectrographically Pure Metals (Prof W Hume-Rothery) 1794
Spectrometer (Mass) Application of the, to Polysaccharide Chemistry (Dr P A Finan and Dr R I Reed), 1866
Spectrometers (Wide-range Grating) Resolution of (Dr A E Martin), 975
Spectrophotofluorometric Assay of Griseofulvin (Carole Bedford, K J Child and E G Tomich), 364
Spectrophotometry (Infra-Red) Polyethylene Absorption Cells for (Trevor Robinson), 448
Spectroscopic Examination (Direct), of Electrophoretic Zones in Agar Gel (Dr G H Beaven and W B Gratzer), 359
Spectroscopic Identification of Alpha-Emitting Nuclides in Biological Material (Prof W V Mayneord and C R Hill), 667
Spectroscopy Conference Second Australian (Dr Norman S Ham), 1195
Spectroscopy Group (Radiofrequency), and the Colloque AMPERE Joint Discussion on Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 157
Spectroscopy (Atomic Absorption) Determination of Magnesium in Blood Serum by (Dr J B Willis), 186
Spectroscopy (Subjective Light Pattern), in the Encephalographic Frequency Range (Prof M Knoll and J Kugler), 1823
Spectrum of Turbulence at Very High Reynolds Number (H L Grant, A Moilliet and Prof R W Stewart), 808
Spectrum (Absorption), of Flavin Adenine Dinucleotide Change of, by its Binding with both D-Amino Acid Oxidase Apo-Protein and Benzoate (Dr Kunio Yagi, Takayuki Ozawa and Minoru Harada), 1938
Spectrum (Infra-Red), of Bacteriochlorophyll in *Chromatium* Influence of Carotenoids on the (Dr J A Bergeron and Dr R C Fuller), 1340
Spectrum (Red-Shift Absorption), of the Cygnus-A Radio Source (Dr R D Davies and Dr R C Jennison), 803

Spectrum Analyser (Narrow-Band) Observations of the Fine Structure of Enhanced Solar Radio Radiation with a (Oystein Elgaroy), 887
Spectrum Changes (Cosmic Ray Energy) Evidence for, during a Forbush Decrease (K W Ogilvie and M M Winn), 888
Speed (High) Computing (Dr S H Hollingdale), *review* by E M Deeley, 1832
Speirs, Dr R L Potentiation of Contractions after Rest in the Isolated Rat Ventricle Preparation, 66
Spencer, D Isolation and Purification of Nitrate Reductase from Embryos of Germinating Wheat, 682
Spencer, D H T (Bond, R L, and) Coal Science (Sorption Data obtained with Inert Gases on Coal and of Heats of Wetting of Coal in Polar Liquids), 412
Spencer, Prof Mary S Production of Ethylene by Mitochondria from Tomatoes, 1231
Spencer, E L (Chance, Prof Britton, and) Energy Transfer with special reference to Biological Systems (Rapid Establishment of Redox Equilibria in the Cytochromes of Cells and Cell Particles at the Temperature of Liquid Nitrogen), 690
Spencer, P S J, and others Insulin and Hypersensitivity, 2020
Sperm Heads Cross-Linking of Deoxyribonucleic Acid in by Ionizing Radiations (Dr P Alexander and Dr K A Stacey), 958
Spermatozoa Survival of, following Drying (Dr Harold T Meryman and Emanuel Kafig), 470
Spermicidal Effects of Dioctyl Sodium Sulphosuccinate Registration of the (Prof Per Eric Lindahl and Kjell Wedin), 1289
Sperry (Elmer A) Award for outstanding achievement in the field of transportation to be presented to the de Havilland Aircraft Co, Ltd, 595
Sphingomyelin from Horse Spinal Cord Presence of Behinic Acid in (Prof Yasuhiko Fujino and Takashi Negishi), 817
Spice, J E Thermodynamics (Phase Changes in Condensed Systems), 1609
Spiers, Prof F W Some Measurements of Background Gamma-Radiation in Leeds during 1955-59, 1680
Spiers Memorial Lecture of the Faraday Society (Prof Th Forster), 688
Spilogale (Genus) A Taxonomic Revision of the Spotted Skunks of the (R G Van Gelder), 1024
Spin Resonance (Electron) Free Radicals as Studied by (Dr D J E Ingram), *review* by Dr T M Sugden, 1259
  Free Radicals in X-Rayed Seeds of High and Low Water Content, as Measured by (Dr W Klingmuller, Dr G R Lane, M C Saxena and Dr D J E Ingram), 464
Spin Resonance (Electron), and Divalency of some Dithiocarbamates of the Coinage Metals (Cu, Ag, Au), (Tore Vanngard and Stig Åkerstrom), 183
Spin Resonance (Electron) Investigations of *Allium cepa* and *Calliphora vomitoria* (M Edwards, Dr G A Kerkut, K A Munday, Dr D J E Ingram, M C Saxena and K Leach), 1402
Spin Temperature (Prof A Abragam), 954
Spinal Cord (Horse) Presence of Behinic Acid in Sphingomyelin from (Prof Yasuhiko Fujino and Takashi Negishi), 817
Spines of the Sea Urchin, *Diadema setosum* (Leske) Isolation of Echinochrome *A* from the (Kokichi Nishibori), 1234
Spinner, Dr E At the Second Australian Spectroscopy Conference (Vibration Spectra and Structure of the Hydrochlorides of Urea, Thiourea and Acetamide), 1196
Spiral and other Growth Forms of Synthetic Diamonds—a Distinction between Natural and Synthetic Diamond (Prof S Tolansky and Dr I Sunagawa), 1526
Spirit of British Administration and some European Comparisons (C H Sisson), 128
Spirostomum Conjugation in (Prof B R Seshachar and P B Padmavathi), 1510
Spleen in the Mouse Hereditary Absence of the (A G Searle), 1419
Spleen (Intact Mouse) Decrease in Radiosensitivity of the, produced by Hypoxia (Dr L Weiss), 1156
Spleen (Isolated and Perfused Rat) Production of γ- and α Globulins by the (Dr E Espinosa), 1801
Spleen Deoxyribonucleic Acid (Highly Polymerized), labelled with Phosphorus-32 Injected Intraperitoneally into Rats Fate of the (Tamara A Hudnik-Plevnik, Vladimir R Glišin and Marta M Simic), 1818
Splenic Siderosis in Mice treated with Dithiourethane (Prof P N Cowen), 366
Spleno-Pulmonary Venous Anastomosis Establishment of Parenchymatous (Dr George R Walker, Dr Paul Field and Dr Patrick E Conen), 703
Sponge-hydrostatic and Weeping Bearings (Mechanism of Animal Joints), (Dr C W McCutchen), 1284
Sponsored Research in Great Britain, 235
Spontaneous De-amination of Amino-acid Phosphates under Physiological Conditions (Dr Mella Paecht and Prof A Katchalsky), 1489
Spontaneous Leukaemia in *AKR* Mice Chromosome Complement of (H F Stich, R Wakonig and Dr A A Axelrad), 998
Sporadic *E* Ionization A Relation between Giant Travelling Disturbances and (L H Heisler), 1788
Sporangiophores (*Phycomyces*) Gallic Acid in (David S Dennison), 2036
Spore Formation in *Bacillus licheniformis* Antibiotic Production as a Function of (Robert W Bernlohr and G D Novelli), 1256
Spore Morphology (Fungal) '*LO*-Analysis' as an Aid in the Study of (Dr M M Payak), 738
Spores of *Bacillus coagulans* var *thermoacidurans* Role of the Glycolytic Enzyme System in the Germination of (Prof Mikio Amaha and Tomoko Nakahara), 1255
Spores of Morphological Variants of *Streptomyces erythreus* Strains An Electron-Microscopic Study of (L Dolezilova, Z Vanek and O Králík), 1888
Sporidesmium bakeri recorded from Victoria, Australia (B S Janes), 1327
Sporidesmium bakeri and Facial Eczema of Sheep in the Field (R H Thornton and D P Sinclair), 1327
Sporn, Philip, and others (edited by) The Economics of Nuclear Power, including Administration and Law, Vol 2, *review* by R Brightman, 1673
Spot Tests for Steroids applied on Paper Use of Porter–Silber and Schiff Reagents as, and their Application to the Study of Rat Adrenal Lipids (Dr Marion K Birmingham), B A 67
Spots (Luminous), on Electrodes in Insulating Oil Gaps (T W Dakin and Daniel Berg), 120
Spotted Skunks of the Genus *Spilogale* A Taxonomic Revision of the (R G Van Gelder), 1024
Spring, Prof F S Retirement from the chair of chemistry in the Royal College of Science and Technology, Glasgow, 233, work of, 233
Sproule, D O (Smith, Piroska (*nee* Vermes), and) Experiments on the Acousto-Electric Effect, 264
Sputnik III The Continued Progress of Satellite 1958δ_2 (B R May and D E Smith), 765
  Signals from Satellite 1958δ_2 (B G Pressey), 261
Sputniks and After (Karl Gilzin), translated from the Russian by Pauline Rose, *review* by D G King-Hele, 836
Squamous Epithelia in the Guinea Pig Renewal Times of some (H Platt), 1654
Srb, A M Cytoplasmic Inheritance (Effects of Mutant and Normal Cytoplasms on *Neurospora* Phenotypes), 1012
Sreenivasan, A, and others Pantothenic Acid Deficiency and Ubiquinone Levels in Rat Liver Mitochondria, 1867
Sreenivasaya, Prof M Biochemical Research in India (Study of Enzymes both by the Ultra-micro- as well as by Micro-dilatometric Methods), 1367
Srinivasachar, D Nuclear Deoxyribonucleic Acid Content and Endopolyploidy in the Meristem of Onion Roots, B A 80
St Amand, Prof W, and Smith, L H Interstrain Ovarian Transplantation in Lethally Irradiated Mice after Bone Marrow Therapy, 1503
St George's Hospital Medical School, London Appointment of Dr G R Hilson as reader in bacteriology, 322
  Appointment of Dr D Dexter as reader in morbid anatomy, 322
St Lawrence Seaway and Power Projects—Geographical Background (Prof T L Hills), B A 49
St Salvator's College, St Andrews Appointment of Dr D Bijl as reader in natural philosophy, 684
  Appointment of Dr F D Gunstone as senior lecturer in chemistry, 684
  Appointment of Dr A R Mitchell as senior lecturer in mathematics, 684
Stability of Metal Complexes of Oxine and its Sulphonic Acid (Prof Adrien Albert and Prof Reino Nasanen), 449
Stability (Configurational), of Deoxyribonucleic Acid in Solution Influence of Counterion Association on the (F Ascoli, C Botre, V Crescenzi, A Mele and Prof A M Liquori), 1482
Stability (Glutathione), of the Erythrocytes in Iranians (Dr D G Walker and Dr J E Bowman), 1325
Stability (Relative), of the Halogenoplatinates A Radiochemical Tracer Study of the (A J Poe and M S Vaidya), 1139
Stability (Suspension), of Red Blood Corpuscles Effect of Polyphoretin Phosphate on the (Dr Bengt Fries), 62
Stabilization of Glyceraldehyde-3-phosphate Dehydrogenase Role of the Co-enzyme in the (P Elodi and G Szabolcsi) 56
Stabilization (d c), of Transistor Circuits Use of the Silicon Resistor in the (J T Zakrzewski and D H Mehrtens), 811
Stable *L* Forms of *Proteus P* 18 Distribution of Nucleic Acids among Different (Prof P Mandel, M Sensenbrenner, P De Gregorio and A M Bader), 566
Stacey, Dr K A, and others Disorganization of the Secondary Structure in Proteins exposed to Ionizing Radiations in the Solid State, 226
Stacey, Dr K A (Alexander, Dr P, and) Cross-Linking of Deoxyribonucleic Acid in Sperm Heads by Ionizing Radiations, 958
Stacey, Prof M Medical Aspects of Complex Carbohydrates (Presidential Address to Section B (Chemistry) of the British Association for the Advancement of Science), B A 42
  Rocket Propulsion (Possibility of using Fluorine in Propulsion Systems), 1267
Stacey, Prof M, and others Some Observations on certain Mucoproteins containing Neuraminic Acid, B A 68
  Action of Manganese Dioxide on Simple Carbohydrates, 1301
  N-Methylation of Methyl 2-Acetamido-2-Deoxy-α-D-Glucopyranoside, 1718
Stacey, W O (Cameron, A, and) Coal Science (Ultra-fine Structure of Coals and Chars—Two Distinct Pore Systems in Chars prepared from Brown-coals), 413
Stadler, Dr D R Growth Patterns in *Neurospora*—Genetic Control of a Cyclic Growth Pattern in *Neurospora*, 170
Staff in Industry and Commerce—Management of Workers whose Skills are mainly Mental or Social rather than Manual (E M Barling), 319
Staff (Scientific), in New Zealand, 854
Stage (Perfect) Production of a, in a Nutritionally Deficient Mutant of Pathogenic *Fusarium oxysporum* after Ultra-violet Irradiation (E W Buxton), 1258
Stages (Different), of their Development Antibacterial Substances of Coniferous Seedlings at (R Vamos and L Vida), 915
Stages (Main), of Social Evolution in Man (Dr Max Pettersson), 481
Stagg, Dr J M Auroral Frequency Lines, 262
  Elected president for 1959-60 of the Royal Meteorological Society, 1108
Staggers (*Phalaris*) Blood Acetylcholinesterase in (Dr D J Walker), 1411
Stahmann, Prof M A, and others Immunochemical Studies of Polypeptidyl Proteins and Synthetic Polypeptides, 549
Staining of *Hevea* Latex Ultracentrifugation and (G F J Moir), 1626
Staining (Silver) Action of Ribonuclease on Nerve Axoplasm as Demonstrated by (R K Winkelmann and Robert W Schmit), 553
Stainless Steel (Austenitic) Chromium Distribution around Grain Boundary Carbides found in (B E Hopkinson and K G Carroll), 1479
Stainsby, Dr G Gelation (The Mechanism of Gelation), 863
Stamm, Dr Otto Awarded a Swiss Fellowship in Chemistry for 1959-60 by the Ramsay Memorial Fellowships Trustees, B A 16
Stamp, Prof L Dudley More Land-Use Planning, 27
Standard (Time) An Improved Caesium Frequency and (Dr L Essen and J V L Parry), 1791
Standard Clots (Human) Urokinase-Induced Fibrinolysis of (Dr Kuro N von Kaulla), 1320
Standards, United States National Bureau of *Journal of Research* to be published in four separate Sections, 319
  Handbook 69, Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure, 939
Standards Organization, International First Meeting of Technical Committee No 93, 514

Standing Crops (Marine) Proximate Analysis of (Dr T R Parsons and Dr J D H Strickland), 2038
Standley, Dr K J Appointed to a readership in physics in the University of Nottingham, 410
Standley, Paul C, and Steyermark, Julian A Flora of Guatemala, 771
Stanković, Dr V, and Sestan, N Effect of Whole-body X-Irradiation on the Insulin Resistance of Fasted Rats, 1816
Stanley, Dr E Principles of Modern Physics, *review*, 1438
Stanley, Dr J S Alkali Ion Determinations by means of Glass Electrodes (Application of Glass Electrodes responsive to Sodium to the Study of Micelle Formation in Solutions of Paraffin Chain Salts and Dyestuffs), 1617
Stanley, Dr Wendell M Appointed chairman of the Department of Virology in the University of California, 26
Stannius from Winter Flounder (*Pseudopleuronectes americanus*) Failure of Corpuscles of, to Synthesize Adrenocorticosteroids *in vitro* (Dr J G Phillips and Dr P J Mulrow), 558
Stapel, Chr, and others Recognition of Diseases and Pests of Farm Crops, *review* by F C Bawden, 1258
Staphylocoagulase Inhibition by Pooled Human Gamma-Globulin (Prof Murray M Streitfeld, Prof Bennett Sallman and Seymour M Shoelson), 1665
Staphylococcal-free Coagulase Activation of, by Purified Human Prothrombin (G Haughton and E S Duthie), 116
Staphylococci Rate of Appearance of Mutants with Respiration-deficiency in (G F Gause, G V Kochetjova and N A Sorbaeva), 1821
Staphylococci in Normal Human Serum Influence of Coagulase on the Growth of (Dr K Wlodarczek and Dr J Jeljaszewicz), 1514
Staphylococcus albus Growth of *Bacterium coli* and, in Heavy Water (Elizabeth van Horn and Dr G C Ware) 833
Staphylococcus aureus Selective Inhibition of Ribonucleic Acid Synthesis in, by Vancomycin (Prof D C Jordan and W E Inniss), 1894
Staphylococcus aureus and *Micrococcus lysodeikticus* Cell-Wall Mucopeptides of (H J Rogers and H R Perkins), 520
Staphylolysin Some Pharmacological Effects of, on the Isolated Rat Uterus (Dr B Wiegershausen), 2017
Star Catalogues (Astronomische Gesellschaft), 856
Starch Interaction of Anti-Staling Agents with (Prof E J Bourne, A I Tiffin and Dr H Weigel), 547
  Interaction of Sucrose Stearate with (Prof E J Bourne, A I Tiffin and Dr H Weigel), 110
Starch-Gel Electrophoresis Separation of Fast-Moving γ-Globulins by (Dr M D Poulik, Dr W W Zuelzer and Dr R Meyer), 1800
  Separation of Prealbumins by (Dr M D Poulik), 1067
Starch-Gel Electrophoresis of Seminal Plasma, Serum and Bile Visualization of Acid and Alkaline Phosphatase after (Dr Bengt Estborn), 1636
Starch Gel Electrophoretic Patterns Localization of Haemocyanin on (J R Whittaker), 193
Starch Granules (Potato) Physical and Chromatographical Observations of γ-Irradiated (Akira Mishina and Ziro Nikuni), 1867
Stars Structure and Age of the (C B Haselgrove and F Hoyle), 1986
Stars and Man Of (Dr Harlow Shapley), *review* by Dr W L Sumner, B A 3
State Hospitals and the—Hospital Organization and Administration under the National Health Service, Sixth and Final Research Report (Creative Leadership in a State Service—a General Survey by Sir George Schuster), 1087, 1201
State Service Creative Leadership in a—a General Survey (Sir George Schuster), (Hospitals and the State—Hospital Organization and Administration under the National Health Service, Sixth and Final Research Report), 1087, 1201
Static Deformation of Armco Iron Dynamic and (H P Tardif and P Chollet), 1917
Statics Engineering, *review* by T M Charlton, 1674
Statics (Engineering) Elements of (Prof H Deresiewicz), *review* by T M Charlton, 1674
Statistical Methods, *review* by W J Langford, 1523
Statistical Physics (L D Landau and E M Lifshitz), translated from the Russian by E Peierls and R F Peierls, *review* by Dr H Steeple, 664
Statistical Physics Elementary (Prof C Kittel), *review* by Dr G M Bell, 1178
Statistical Reasoning The Fundamentals of (M H Quenouille), *review* by Dr D J Finney, 217
Statistical Review of England and Wales for the Year 1957 Part 2, Tables, Civil (Registrar General), 1107
Statistical Society, Royal Election of Sir Hugh Beaver as president, 26
Statistical Society of New South Wales Publication of the *Australian Journal of Statistics*, 504
Statistical Techniques Principles of (P G Moore), *review* by W J Langford, 1523
Statistics, an Introduction (Prof D A S Fraser), *review* by J Durbin, 1008
Statistics Awards for Study in (University of Chicago), 772
  A First Course in (Robert Loveday), *review* by J Durbin, 1008
  Labour (Ministry of Labour and National Service, Guides to Official Sources, No 1), B A 15
  Marriage and Divorce (Demographic Yearbook 1958, Special Topic), (United Nations), *review*, 1525
Statistics, Australian Journal of (Statistical Society of New South Wales), 504
Statistics relating to Consumption and Refinery Production, 1957 and 1958 United Kingdom Petroleum Industry (Petroleum Information Bureau), 855
Statistics of Extremes (Prof E J Gumbel), *review* by R N Curnow, 754
Statistics in Physics Applications of, *review* by Dr H Steeple, 664
Statistics of Public (Rate Supported) Libraries in Great Britain and Northern Ireland, 1957-1958 (Library Association), 592
Statistics (Divorce), in Britain, 1107
Statistics (Heads-Tails), for Two Partially Distinguishable Coins (Gabriel Weinreich), 1825
Statistics (Morbidity), from General Practice, Vol I, General (Studies on Medical and Population Subjects No 14), (Dr W P D Logan and A A Cushion), 154
Statistics Teaching Trends in, *review* by J Durbin, 1008
Status (Antibody), of Mice and Response of their Litters to Parotid Tumour Virus (Polyoma Virus), (Lloyd W Law, Clyde J Dawe, Wallace P Rowe and Janet W Hartley), 1420
Steady-Rate Universe and the Deduction of Continual Creation of Matter (Prof V A Bailey), 537, (Prof G Bondi) 537
Stearate (Sucrose) Interaction of, with Starch (Prof E J Bourne, A I Tiffin and Dr H Weigel), 110
Stearic Acid in Monolayers Absorbed from Solution Concentration of (George L Gaines, jun), 1139
Steczek, Katalin, and others A New Trichothecin-like Antifungal Antibiotic, 908
Steel, Dr R (edited by) Biochemical Engineering—Unit Processes in Fermentation *review* by Dr N Blakebrough, 1598
Steel Relationship of pH to Aerobic Corrosion Fatigue Life of (Dr Frederick J Radd, L Hugh Crowder and Louis H Wolfe), 2008
Steel in China A History of Iron and, *review* by Prof F C Thompson, 1830
Steel (Austenitic Stainless) Chromium Distribution around Grain Boundary Carbides found in (B E Hopkinson and K G Carroll), 1479
Steel (Mild) Surface-Hardened by Carbo-Nitriding Identification of the High-Temperature Constituent in (M A H Howes, G T F Jay, K Sachs and D Wilkinson), 1312
Steel Technology (Iron and), in China The Development of (Dr Joseph Needham), *review* by Prof F C Thompson, 1830
Steele, Dr J H Polar Front Survey (Hydrography—Shetland–Faroe–Iceland Region), 1181
Steelink, Dr Cornelius Colour Reactions of certain Phenols with Ehrlich's Reagent, 720
Steels during Quenching and Tempering The Phenomena occurring in (Academician G V Kurdjumov), 1450
Steeple, Dr H Applications of Statistics in Physics, *review*, 664
Steers Prof J A Coast Erosion and Accretion, 499
Steger, E H Clay Minerals (Problems in Civil Engineering), 779
Stegwee, Dr D Esterase Inhibition and Organophosphorus Poisoning in the House-Fly, 1253
Stehbens, Dr W E Flow Properties of Biological Systems (Turbulent Conditions in Blood Flow), 1540
Stein, Gabriel (Loeff, Israel, and) Aromatic Ring Opening in the Presence of Oxygen in Irradiated Solutions, 901
Steinbach, Marion, and Pejaudier, L The Behaviour of Haptoglobin during Routine Fractionation, 362
Steinberger, R Chemistry of Propellants (Solid Propellants—Properties of Double-Base Forms), 778
Steinbuch, M, and others Modifications in Immunological Behaviour, Electrophoretic Mobility and Colourability of Substituted Human Serum Proteins, 1571
Steinfeld, Dr Julius I A New Approach to Schizophrenia, *review* by Prof Martin Roth, 487
Steinhaus, Edward A, and Smith, Ray F (edited by) Annual Review of Entomology, Vol 4, *review* by Dr P T Haskell, 489
Stellar Associations from Galactic Gas Formation of (Prof Vladimir Vand), 441
Stem Wounds (Apple) *Gloeosporium* in (R O Sharples), 243, (A T K Cooke), 244
Stendall, J A S Science by the Upper Form, 596
Stener, Dr Bertil Does an Increase in the Tension in a Ligament elicit Reflex Muscular Responses?, 1495
Stephen, D At the Conference of the Mammal Society of the British Isles (Calving Season of Roe Deer), 30
Stephen, Dr I (Brown, G, and) Clay Minerals (Studies in Iddingsite), 780
Stephen, Dr W I Advanced Analytical Chemistry, *review*, 1525
  Classical Chemical Analysis, *review*, 1756
Stephens, Dr C G Awarded the Verco Medal of the Royal Society of South Australia, 1611, work of, 1611
Stephens, J, and others Unidentified Growth Factors, 271
Stephens, Jack D, and others Macromolecular Components of *Chlorella pyrenoidosa*, 963
Stephenson, P J (Blundell, D J, and) Palaeomagnetism of some Dolerite Intrusions from the Theron Mountains and Whichaway Nunataks, Antarctica, 1860
Stercobilin and *d*-Urobilin Optical Activity of (Prof C H Gray, P M Jones, Dr W Klyne and Dr D C Nicholson), 41
Stereochemical Properties Photochemical and, of Carotenoids at Low Temperatures (Staff of the Biological Laboratories of Harvard University)—Photochemical Behaviour of Retinene (Dr Lawrence Jurkowitz), 614, *Cis-trans* Isomerism and Steric Hindrance (John N Loeb, Paul K Brown and Prof George Wald), 617, Discussion (Prof George Wald) 620
Steric Aspects of the Chemistry and Biochemistry of Natural Products (Biochemical Society Symposium on), 947
Steric Effects in Conjugated Systems—Proceedings of a Symposium held at the University, Hull, 1958, by the Chemical Society (edited by Dr G W Gray), *review* by Dr G Eglinton, 1522
Steric Effects in Organic Molecules, *review* by Dr G Eglinton, 1522
Steric Hindrance *Cis-trans* Isomerism and (Photochemical and Stereochemical Properties of Carotenoids at Low Temperatures), (John N Loeb, Paul K Brown and Prof George Wald), 617
Sterility in *Lathyrus odoratus* L (Dr J R Ellis and M A Burton), 204
Sterkfontein A Bone Implement from (Dr J T Robinson), 583
Sterling (Sir Louis) Premium of the British Institution of Radio Engineers awarded to Dr A van Weel, 857
Stern, H, and others Fine Structure in Cells of Pea and Wheat Embryos, 505
Stern, Dr Marvin (edited by Morton Alperin and) Vistas in Astronautics—First Annual Air Force Office of Scientific Research Astronautics Symposium, *review* by D G King-Hele, 663
Stern, Dr Marvin (Gamow, Prof George, and) Puzzle-Math, *review* by Prof T A A Broadbent, 217
Stern, Max H, and others Isomers of Vitamin A in Fish Liver Oils, 1377
Stern, T W, and others α-Radioactivity of Cerium-142, 630
Sternoberflachen-Doppelsterne (Handbuch der Physik, herausgegeben von S Flugge, Band 50, Astrophysik I), *review* by Prof R O Redman, B A 3
Steroid Metabolism in Different Tissues and Subcellular Fractions Distribution of Enzyme Systems responsible for (Virendra B Mahesh and Frank Ulrich), 1147
Steroids applied on Paper Use of Porter–Silber and Schiff Reagents as Spot Tests for, and their Application to the Study of Rat Adrenal Lipids (Dr Marion K Birmingham), B A 67

Steroids and related Compounds Effect of, on the Growth of Dermatophytes (Dr F W Chattaway, J D Townsley and A J E Barlow), 1731
Steroids (Adrenocortical) Biosynthesis and Secretion of (Biochemical Society Symposium on), 415
Sterol-Balance Experiments in Humans (Dr Harald Schon), 1872
Sterol Glycosides in Oilseed Phospholipids (Dr Francis Aylward and B W Nichols), 1319
Steuer, Robert O, and Saunders, J B de C M Ancient Egyptian and Cnidian Medicine, *review* by Dr Douglas Guthrie, 662
Steven, Prof H M, and Carlisle, A The Native Pinewoods of Scotland, *review* by Prof E W Jones, 133
Stevens, Dr B Energy Transfer with special reference to Biological Systems (Vapour Phase), 689
Stewart, C M, and others Possible Role of Glycerol in the Winter-Hardiness of Insects, 288
Stewart, Dr C P Elected president of the Association of Clinical Biochemists, 857
Stewart, Doreen L (Brown, F, and) Effect of Proflavine on the Formation of Virus of Foot-and-Mouth Disease and its Infective Ribonucleic Acid in Pig Kidney Tissue Culture Monolayers, B A 74
Stewart, J W Appointed to the University of London readership in haematology at Middlesex Hospital Medical School, London, 595
Stewart, P, and others Effects of Irradiation of Nerve on Muscular Response, 734
Stewart, Dr R D, and others Post-Exposure Analysis of Organic Compounds in the Blood by a Rapid Infra-red Technique, 192
Stewart, Prof R W, and others A Spectrum of Turbulence at Very High Reynolds Number, 808
Stewart, Air Commodore W K Behaviour in Conventional and Extra-Terrestrial Flight, 578
Stewart, W N Origin and Dispersal of Flowering Plants (Proposal that Conrad's Monophyletic Classification of Vascular Plants be revived), 1200
Steyermark, Julian A (Standley, Paul C, and) Flora of Guatemala, 771
Stibbs, Dr D W N Appointed to the Napier chair of astronomy in the University of St Andrews, 768, work of, 768
Stich, H F, and Emson, H E Aneuploid Deoxyribonucleic Acid Content of Human Carcinomas, 290
Stich, H F, and others Chromosome Complement of Spontaneous Leukaemia in AKR Mice, 998
Stickland Dr L H (Laws, Dr J O, and) Changes in Adenosine Di- and Tri-phosphate Concentrations in the Early Stages of the Action of Yeast on Glucose, 1246
Stiles, Dr W S Colour Reproduction, *review*, 1092
Stimulants (New Brain-Stem) N-Substituted 7-Methoxy-8-Aminomethylchromones and Flavones— (P Da Re, L Verlicchi, Dr I Setnikar, W Murmann and M J Magistretti), 362
Stimulated Animals (Control and) Quantitative Assay of Compounds in Isolated, Fresh Nerve Cells and Glial Cells from (Prof Holger Hydén), 433
Stimulation (Olfactory) A Specific Response in the Hippocampus of the Rabbit to (B G Cragg), 1697
Stimulation (Sexual) Influence of, on the Metabolic Activity of Deoxyribonucleic Acid in the Seminal Vesicle (Dr S R Pelc), 1414
Stimulatory Effect of Foreign Compounds on Ascorbic Acid Biosynthesis and on Drug-Metabolizing Enzymes (Dr A H Conney and Dr J J Burns), 363
Stipitatonic and Puberulonic Acids Tropolone Biosynthesis—the Enzymatic Decarboxylation of (Prof Ronald Bentley and Clara P Thiessen), 552
Stirling, Dr C J M Appointed lecturer in organic chemistry at Queen's University, Belfast, 322
Stjarne, L (Bygdeman, M, and) Effects of 1,4-Dihydrazinophthalazine on Organ Content and Adrenal Medullary Secretion of Catechol Amines, 1646
Stjarne, L, and Schapiro, S Effects of Reserpine on Secretion from the Denervated Adrenal Medulla, 2023
Stochastic Processes Fluctuation Phenomena and (Physical Society Conference on), 509
Stochastic Rectification of Non-linear Clocks (David G Kendall), 1476
Stockbridge, H C (Renbourn, Dr E T, and) Ergonomics, its Place in Industry (Activities in the Clothing and Stores Experimental Establishment of the Ministry of Supply), B A 21
Stocker, Dr B A D, and others Production of Colicine by Single Bacteria, 337
Stoddart, J L Floral Initiation and its Relationship to Growth-Stage in Red Clover (*Trifolium pratense* L), 559
Stoicheiometric Gas Hydrates Some (Dr D N Glew), 545
Stoichiometry of Bismuth Telluride and related Compounds (G Offergeld and J van Cakenberghe), 185
Stoker, Prof M G P, and others Statement on Biological and Chemical Warfare, 1018
Stokes, Dr A R Fluctuation Phenomena and Stochastic Processes (Light Scattering by Semi-stiff Chain Molecules), 510
Stolk, Prof A Effect of Thiouracil and Thyroxine on Development and Growth of Cutaneous Melanoma in Killifish Hybrids, 562
  Glaucoma Species in the Central Nervous System of the Carp, 1737
  Development of the Yolk Nucleus in the Oocytes of some Fishes, 1746
Stolpe, C v d (Kroon, D J, and) Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Stomach Contents of Spawning Quinnat Salmon (J S Bullivant), 71
Stomoxys Control in Uganda, East Africa (H C M Parr), 829
Stone, Dr F S Heterogeneous Catalysis, *review*, 1974
Stone, Dr F S (edited by D H Everett and) The Structure and Properties of Porous Materials—Proceedings of the Tenth Symposium of the Colston Research Society held in the University of Bristol, 1958, *review*, 1525
Stone Implements from Western Nigeria (E L Kostick, C N Williams and S A Williams), 124
Stonehill, Prof H I Visual Illustration of University Lectures (Use of Television as a Medium of Instruction at College- and University-level in the United States), 516
Stoner, Prof E C Aspects of Solid State Physics, *review*, 1753
Storage of Peas A Chemical Effect of Ethylene during the (Prof Frank A Lee), 462
Storage (Food) Infestation Control, a Service to Agriculture and (Ministry of Agriculture, Fisheries and Food), 941
Storage (Vitamin A), in the White Rat Effect of 'Amino-Acid Imbalance' on Growth and (M Rechcigl, jun, S Berger, J K Loosli and H H Williams), 1404
Storey D J Appointed lecturer in electrical engineering at the University of Bristol, 1613
Storm (Cosmic-Ray), of February 11, 1958 North-South Anisotropy and Anticipatory Increase of Intensity associated with the (Dr V Sarabhai and R Palmeira), 1204
Storvick, T M Thermodynamics (Phase Changes in Condensed Systems), 1609
Story of Flight The (Victor Wall), 1535
Stothert Research Fellowships of the Royal Society awarded to W D Butt, R A Webster and to J A Hunt), 595
Stott, Alderman F J At the Annual Conference of the Library Association (The Public Library as a Major Instrument of Education), 1456
Stout, J W Thermodynamics (Phase Changes in Condensed Systems), 1609
Stover, Dr R H A Rapid and Simple Pathogenicity Test for Detecting Virulent Clones of *Fusarium oxysporum* f *cubense* using Seedlings of *Musa balbisiana*, 1591
Stow, R L Titanium as a Gettering Material, 542
Strain, Harold H and others Chloroplast Pigments of Deuterated Green Algae, 730
Strain (An Attenuated), of Canine Distemper Virus in Tissue Culture (Prof Gunnar Rockborn), 822
Strain (Non-Gummy Chromogenic), of *Azotobacter vinelandii* (J A Bush and Prof P W Wilson), 381
Straining Clays Swelling Forces in (E L Greacon), 1695
Strains of *Brucella* Organisms Bacteriophage Typing applied to (Prof G C van Drimmelen), 1079
Strains (Low- and High-Temperature), of *Chlorella* Tabular Comparative Data for the (Dr Constantine Sorokin), 613
Strains (Sensitive), of the Blue Tick, *Boophilus decoloratus* Contents of Cystine-Cysteine, Glutathione and Total Free Sulphydryl in Arsenic-resistant and (Dr J S Harington), 1739
Strains (*Streptomyces erythreus*) An Electron-Microscopic Study of Spores of Morphological Variants of (L Dolezilova, Z Vanek and O Kralik), 1888
Strains (Tomato and Banana), of *Pseudomonas solanacearum* Comparison of Slime from (Dr W F Dudman), 1969
Strange, R E (Powell, the late Joan F, and) Synthesis of Dipicolinic Acid from *αε*-Diketopimelic Acid, 878
Strangways-Dixon, J Hormonal Control of Selective Feeding in Female *Calliphora erythrocephala* Meig, 2040
Stranks, Dr D R (Grossbard, Dr Erna, and) Translocation of Cobalt-60 and Caesium-137 by Fungi in Agar and Soil Cultures, 310
Strategy of Chemotherapy—Eighth Symposium of the Society for General Microbiology, 1958 (edited by S T Cowan and E Rowatt), *review* by Prof H Berry 133
Stratigraphy Tanganyikan, 1688
Stratton, Dr F, and Renton, Dr P H Practical Blood Grouping, *review* by Dr R A Zeitlin, 130
Strawberries Chemical Control of Eelworms in (R S Pitcher), 25
Strawberry Effect of Gibberellic Acid on the Initiation of Flowers and Runners in the (P A Thompson and C G Guttridge), B A 72
Strawberry Plants Transmission of a Virus to, by a Nematode (*Xiphinema* sp), (Asharfi Jha and Dr A F Posnette), 962, *erratum*, 1192
Streams (Photon) Fluctuations in (Dr Peter Fellgett, Dr R Clark Jones and Dr R Q Twiss), 967, (Dr C W McCombie), 969
Street, Prof H E (Vaidyanathan, C S, and) A Non-Dialysable Inhibitor of Glutamo-Transferase present in Excised Tomato Roots, 347
  Nitrate Reduction by Aqueous Extracts of Excised Tomato Roots 531
Streeter, D T Awarded a Nature Conservancy Research Studentship for postgraduate training in ecology (botany), 156
Streitfeld, Prof Murray M, and others Staphylocoagulase Inhibition by Pooled Human Gamma-Globulin, 1665
Strength of a Grooved Stud (D C Herbert), 897
Strength of Glass Fibres (J G Morley), 1560
Strength (Acid), of Propionate Side-Chains of Haematin Decrease in, on Reduction to Haem (Dr J E O'Hagan), 1808
Strength Impairment Mechanism of Glass in Aqueous Systems (Frederick J Radd and Donald H Oertle), 976
Streptococcal Protoplasts Formation of Streptolysis S by (Dr Yoshiharu Maruyama, Sadaka Sugai and Prof Fugio Egami), 832
Streptococci (Group D) Group and Typespecific Polysaccharides of (Dr S D Elliott), 1342
Streptococcus bovis Formation of Leucrose in Dextran-producing Cultures of (R W Bailey and Prof E J Bourne), 904
Streptolysin S Formation of, by Streptococcal Protoplasts (Dr Yoshiharu Maruyama, Sadako Sugai and Prof Fugio Egami), 832
Streptomyces Cytochrome System of (Dr D J Niederpruem and Dr D P Hackett) 1954
Streptomyces erythreus Strains An Electron-Microscopic Study of Spores of Morphological Variants of (L Dolezilova, Z Vanek and O Kralik), 1888
Streptomycin Solutions Influence of, on the Interaction between the Agglutinating Sera and the Corresponding Red Blood Cell Receptors (Dr M Kout and Dr Z Kubickova), 639
Streptomycin and Dihydrostreptomycin Interaction of, with Apo- and Co-dehydrogenases (Prof K Michalska), 987
Stretton, A O W (Ingram, Prof V M, and) Genetic Basis of the Thalassaemia Diseases, 1903
Striated Muscle A Peripheral Effect of the Bromide Ion on the Contraction of (Dr D K de Jongh and H A Linnewiel), 1240
Strickland, A H Biological Problems arising from the Control of Pests and Diseases, 1101
Strickland, Dr J D H (Parsons, Dr T R, and) Proximate Analysis of Marine Standing Crops, 2038
Striga An Insect attacking (C N Williams and G H Caswell), 1668
Striga Seedlings Action of Inhibitor-*β* on the Growth of (C N Williams), 1577

Stringer, J D Appointed a lecturer in mechanical engineering at the University of Sheffield, 684
Strnad, R (Bridges, T, and) Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Zone Melting of Single-crystal Sapphire Rod 0 1 in in Diameter), 692
Stroma Role of, in Haemoglobin Synthesis—Experiments on Duck Red Cells *in vitro* (A Breccia, A L Fantola, E Lazzarini and A Giustina), 1878
Strong, Dr H M, and others Preparation of Diamond, 1094
Strong, Dr John Concepts of Classical Optics, *review* by Dr J E Geake, 130
Strong Pulses of Ionic Current Effects of the Energy of, on Micro-organisms in Suspension (B S Gossling), 1881
Strontium' (Anomalous 'Common), in Granite (W Compston and Dr P M Jeffery), 1792
Strontium-90 in the Australian Environment, 1957-58 (Dr F J Bryant, L J Dwyer, Dr J H Martin and Prof E W Titterton), 755
Strontium-90 in Human Diet in the United Kingdom (Agricultural Research Council), 1111
Strontium-90 in Rats Attempts to Modify the Normal Metabolism of (Dr V Volf), 1401
Strontium and Caesium Removal of, from Milk (Dr B B Migicovsky), 374
Strontium-90, Strontium-89 and Caesium-137 Levels in Milk Current Trends of (W Anderson, L K Burton and J O Crookall), 89
Strontium Content of Milk Implications of Restricting Cows to a Clover-free Diet in order to Reduce the (Dr David Purves), 1408
Stross, Dr Barnett Museums and Finance, 598
Stross, F H, and others Carrier Gas and Sensitivity in Gas Chromatography, B A 54
Structural Effects of Kinetic Heating (Royal Aeronautical Society Discussion on), 30
Strovilas, N G, and others Effect of the Potassium Salt of Gibberellic Acid on the Growth and Reproduction Rate of *Paramecium multimicronucleatum*, 1405
Structural Analysis Linear (Prof P B Morice), *review* by R K Livesley, 1600
  Matrix Algebra in, *review* by R K Livesley, 1600
Structural Defects in Fused and Crystalline Silica (Dr W C Levengood), 1476
Structural Elements of the Bacterial Cell Affinity of Lysozyme to, studied with Enzyme Labelled with Radioactive Iodine (Prof C Weibull, B Zacharias and H Beckman), 1744
Structural Model for Monatomic Liquids including Metallic Liquids (Dr Kazuo Furukawa), 1209
Structural Relations Estimation of Linear and Non-Linear (D E Barton and C L Mallows), 1086
Structure of Bituminous Coals—Evidence from Distribution of Hydrogen (Dr P H Given), 980
Structure of British Industry, a Symposium (edited by Duncan Burn), *review* by Prof A J Brown, 1089
Structure of Cellobiose (Robert A Jacobson Jeffrey A Wunderlich and Prof William N Lipscomb), 1719
Structure of Glass—Proceedings of a Conference held at Leningrad, 1953 (translated from the Russian by E B Uvaroc), *review* by Prof R W Douglas, 134
Structure of α-Hydroxyacetylene Complexes of Platinum (II), (Dr J Chatt, L A Duncanson and R G Guy), 526
Structure of a Melanocyte-stimulating Hormone from the Human Pituitary Gland (Dr J Ieuan Harris), 167
Structure of Precipitated Cadmium Sulphide as studied by Single-Crystal Electron Diffraction Pattern (Dr Ryoitiro Sato), 2005
Structure of Ribonucleic Acid Inactivation of some Animal Viruses by Hydroxylamine and the (Dr Richard M Franklin and Dr Eberhard Wecker), 343
Structure of Science (Wistar Institute of Anatomy and Biology Symposium on), B A 6
Structure of Teichoic Acid from the Walls of *Bacillus subtilis* (Teichoic Acids from Bacterial Walls), (J J Armstrong, Prof J Baddiley and Dr J G Buchanan), 248
Structure of Thymine Hydroperoxide produced by X-Irradiation (B Ekert and R Monier), B A 58
Structure (Crystal), of L-Serine Phosphate (G H McCallum, Prof J Monteath Robertson and Dr G A Sim), 1863
Structure (Dense Laminar), found in Conjection with Cell Membranes in the Anterior Pituitary Gland (Barbara G Barnes), 651
Structure (Electron-Microscopic), of the Sensory Hairs in the Cristae of the Elasmobranch *Raja clavata* A Functional Interpretation of the, in Terms of Directional Sensitivity (Prof O Lowenstein and J Wersall), 1807
Structure (Electron Microscopical) of the Wall of Small Blood Vessels in Human Multiform Glioblastoma (Dr S H M Nystrom), 65
Structure (Financial), of the Colonial Development Corporation Report of the Committee of Enquiry into the 1520
Structure (Fine), in Cells of Pea and Wheat Embryos (G Setterfield, H Stern and F B Johnston), 505
Structure (Fine), of Enhanced Solar Radio Radiation Observations of the, with a Narrow-Band Spectrum Analyser (Oystein Elgaroy), 887
Structure (Fine), in Muscle Ionic Partition and (Dr Shirley E Simon), 1978
Structure (Mitochondrial) Cytochemical Study of (Prof C H Chopra), 656
Structure (Nuclear), of Growing Naked Protoplasts of Yeast (Dr O Nečas), 1664
Structure (Possible Simplified), of Deoxyribonucleic Acid (Dr M H Silk and A O Hawtrey), 1484
Structure (Secondary), in Proteins exposed to Ionizing Radiations in the Solid State Disorganization of the (Dr Peter Alexander, L D G Hamilton and Dr K A Stacey), 226
Structure (Secondary), of Ribonucleic Acid in Solution (Dr R A Cox and Dr U Z Littauer), 818
Structure (Ultra-) Comparative Studies in (Linnean Society of London Symposium on), 1445
Structure (Ultra-), of the Myoneural Junction in Myasthenia Gravis (E R Bickerstaff, J V Evans and A L Woolf), 1500
Structure and Age of the Stars (C B Haselgrove and F Hoyle), 1986
Structure and Chemistry of Proteins (Commonwealth Scientific and Industrial Research Organization Symposium on), 1275
Structure and Physical Properties of Materials Relationship between (Non-Destructive Testing Group of the Institute of Physics and the Societe Française de Metallurgie Discussion on), 1688
Structure and Properties of Porous Materials—Proceedings of the Tenth Symposium of the Colston Research Society held in the University of Bristol, 1958 (edited by D H Everett and F S Stone), *review*, 1525
Structure Analysis and Experimental Techniques (Institute of Physics Conference on), 857
Structure Discontinuity (Weld) Crack Behaviour at a (F J Radd), 543
Structures of Metals and Alloys A Handbook of Lattice Spacings and (Dr W B Pearson) *review* by Dr J A Catterall, 841
Structures (Embryo Sac-like), in the Microsporangia of *Leptomeria billardierii* R Br Occurrence of (Dr Manasi Ram), 914
Structures (Welded) Fatigue of (British Welding Research Association and the Engineering Department of the University of Cambridge Symposium on), 1915
Struve, Prof Otto Appointed the first director of the United States National Radio Astronomy Observatory, B A 14, work of, B A 14
Stuart, Dr A E Awarded a grant by the Lady Tata Memorial Trust, for research on Leukaemia and allied Diseases, 507
Stud (Grooved) Strength of a (D C Herbert), 897
Students, National Union of 1959 Grants Year Book, 770
Studentship (Postgraduate Research) founded by the Phillips Petroleum Co at University College of North Staffordshire, 322
Studentship (a second Postgraduate Research) founded by the United States Rubber Co at University College of North Staffordshire, 322
Studentships (Research), for postgraduate training in Ecology (Nature Conservancy Awards for 1959), 156
Studentships and Scholarships (Royal Commission for the Exhibition of 1851 Awards), 409
Studies New Floristic, 409
  Nuclear (Science Department of the British Council third list of), 235
Studies of Coal (Staff of the British Coal Utilisation Research Association) —Carbonization of Coals in the Presence of Activated Charcoal (R L Bond, A M Godridge, A R Murnaghan, D H Napier and D J Williams), 425 Smoke Emission from Coal and Low-Temperature Chars (D Finch), 426
Studies on Fertility, including Papers read at the Conference of the Society for the Study of Fertility, London 1958 (edited by Prof R G Harrison), *review* by Dr T Mann, 1434
Studies in the History and Methods of the Sciences (Prof Arthur David Ritchie), *review* by Prof A V Hill, 4
Studies in Invertebrate Morphology, in honor of Dr Robert Evans Snodgrass on the occasion of his eighty-fourth Birthday (Smithsonian Institution, Miscellaneous Collections Vol 137), 591
Studies of Noise Problems Recent (Acoustics Group of the Physical Society Symposium on), 414
Studies in Recreation, 1034
Studies on Social Groupings in Fishes (Dr C M Breder, Jr), 865
Studies of its Surface Properties Evidence for a Hydrate of Cellulose from (Dr J M Joubert, Dr G J R Krige and Dr K Borgin), 1561
Studies (Comparative), in Ultrastructure (Linnean Society of London Symposium on), 1445
Studies (Crystallographic), of the Biuret Reaction (Dr H C Freeman, J E W L Smith and J C Taylor), 707
Studies (Dielectric), on Deoxyribonucleic Acid (H G Jerrard and B A W Simmons), 1715
Studies (Five), in the Efficient Communication of Skills New Developments in Training— (edited by Frank A Heller), 421
Studies (Graduate) A University of (Dr Detlev W Bronk), 86
Studies (Immunochemical) of Polypeptidyl Proteins and Synthetic Polypeptides (Prof M A Stahmann, D J Buchanan-Davidson, Dr C Lapresel and Dr P Grabar), 549
Studies (Metabolic and Chemical), of 'Myleran'—Formation of 3-Hydroxytetrahydrothiophene-1,1-dioxide *in vivo*, and Reactions with Thiols *in vitro* (Dr J J Roberts and Dr G P Warwick), 1288
Studies (Palaeomagnetic), of Cenozoic Volcanic Rocks in New Zealand (Dr D S Coombs and Dr T Hatherton), 883
Studies (Rocket), of Emissions caused by Solar Flares (United States National Science Foundation Grant), 406
Study of Corrosion, 1023
Study of Fertility, Society for the Proceedings, Vol 10, Studies on Fertility, including papers read at the Conference, London 1958 (edited by Prof R G Harrison), *review* by Dr T Mann, 1434
Study of Fungal Spore Morphology 'LO-Analysis' as an Aid in the (Dr M M Payak) 738
Study of Man, B A 1
Study based on Mortality Rate and Tumour Incidence Latent Period of X-Ray Induced Ageing—a (Dr H I Kohn and Dr P H Guttman), 735
Study of Organic Reactions Tracer Applications for the (John G Burr, Jr), *review* by Dr A I Scott, 1902
Study of Population (edited by Philip M Hauser and Otis Dudley Duncan), *review* by Dr B Benjamin, 1521
Study of the Preservation and Restoration of Cultural Property, International Centre for the Inauguration of the, 504
  Appointment of Dr H J Plenderleith as first director, 504
Study of Rat Adrenal Lipids Use of Porter–Silber and Schiff Reactions as Spot Tests for Steroids applied on Paper and their Application to the (Dr Marion K Birmingham), B A 67
Study of the Solubility of Water in Hydrocarbons Use of Tritium to (B D Caddock and P L Davies), 2011
Study in Statistics Awards for (University of Chicago), 772
Study (Cytochemical), of Mitochondrial Structure (Prof C H Chopra), 656
Study (Electron-Microscopic), of Spores of Morphological Variants of *Streptomyces* erythreus Strains (L Dolezilova, Z Vanek and O Kralik), 1888
Study (Histochemical), of Monoamine Oxidase in the Developing Rat Brain (Nobuo Shimizu and Nogaaki Morikawa), 650
Study (*In vitro*), of the Anthelminthic Property of *Artemesia monosperma* grown in Egypt (A Sharaf, Z F Ahmed and F Abdel Moneim), 647
Study (Kinetic), of Dextransucrase based on the Langmuir Adsorption Isotherm (W Brock Neely and C F Thompson), B A 64
Study (Mineralogical), on Clays of Japan (Dr Toshio Sudo), *review* by Dr D M C MacEwan 1439

Study (The Proper) of Mankind is Man (Sir James Gray), B A 35
Study (Quantitative), of the Surface Precipitation Reaction A Method for the (Francis T Ashton), 1735
Study (Radiochemical Tracer), of the Relative Stability of the Halogenoplatinates (A J Poe and M S Vaidya), 1139
Study (Solid State Rheological), of the Mechanism of Paraffin-Detergent Interactions in Aqueous Systems (F J Radd and L H Crowder), 443
Study (X-Ray), of Rigid-Body and Internal Vibrations of Organic Molecules (Dame Kathleen Lonsdale and Dr H Judith Milledge), 1545
Studying the Functioning of the Lungs A New Method for (Helge Colldahl, T Alväger and J Uhler), 372
Studying Tumour Blood Supply A Rapid Method for, using Systemic Dyes (Dr R J Goldacre and Dr B Sylven), 63
Stull, D R Thermodynamics (Phase Changes in Condensed Systems), 1609
Stumpf, Dr Paul K (Neilands, Dr J B, and) Outlines of Enzyme Chemistry, second edition, *review* by Dr Edwin C Webb, 1759
Sturge, Ltd, John and E, Birmingham New Research Laboratories of, 1985
Styles, Edward C C (Blain, Dr John A, and) A Lipoperoxidase Factor in Soya Extracts, 1141
Subcellular Fractions Distribution of Enzyme Systems responsible for Steroid Metabolism in Different Tissues and (Virendra B Mahesh and Frank Ulrich), 1147
Subcutaneous Absorption of Urethane in Dehydrated and Fasted Mice (Eigill Hvidberg and Jens Schou), 646
Subcutaneous Thymus Grafts in Thymectomized Mice Inoculated with Leukaemic Filtrate Fate of (J F A P Miller), 1809
Subdivision (Population) Genetical Effects of (P A P Moran), 505
Sub-Genic Mutants in the *r*-Locus of *Drosophila melanogaster* Complementation among the (Dr O G Fahmy and Dr Myrtle J Fahmy), 1927
Subjective Light Pattern Spectroscopy in the Encephalographic Frequency Range (Prof M Knoll and J Kugler), 1823
Subjective Phenomena (Some New), apparently due to Interocular Transfer (Ian P Howard), 1516
Sub-Lethal Doses (Lethal and), of Cottonmouth Moccasin Venom labelled with Iodine-131 Distribution in the Mouse of (Prof J F Gennaro, jun, and H W Ramsey), 1244
Sub-Micro Titration of Derivatives containing Nitro Groups Quantitative Paper Chromatography based on the (L Blom and J Caris), 1313
Sub-Micron Multiple Fibres High-Resolution Fibre Optics using (Dr N S Kapany), 881
Subramanyan, M K Biochemical Research in India (Studies on the Cytology of Yeast), 1367
Subrahmanyan, Dr V Biochemical Research in India, 1367
Subrahmanyan, Dr V, and others Insecticidal Effects of Activated Charcoal and Clays, 1165
Subramaniam, A P A Re-Interpretation of Charnockites, 321
Subsequent Specific Infection of Mice Immunization with Biologically Active Fractions of Deoxyribonucleic Acid and (Dr M Kohoutova), 1965
Substance and Shadow, *review* by Prof R V Jones, 1752
Substance (Antifungal), 6-Methoxybenzoxazolinone Isolation of the, from Field Corn (*Zea mays* L) in Canada (N J Whitney and C G Mortimore), 1320
Substances Plant Growth (Prof L J Audus), second edition, *review* by Prof R L Wain, 925
Substances Inhibiting the Oxidation of Ascorbic Acid Presence in Rose Hips of (Dr G A D Jackson and R B Wood), 902
Substances (Added) Effect of, on the Rate of Reductive Photo-bleaching (Reductive Photo-bleaching of Eosine), (Kengo Uchida, Shunji Kato and Masao Koizumi), 1620
Substances (Antibacterial), of Coniferous Seedlings at Different Stages of their Development (R Vamos and L Vida), 915
Substances (Antigenic) Coating of Red Blood Cells with (Dr K Deutsch) 278
Substances (Interfering), in the Determination of Glucosamine Synthesis (Dr Fiorenzo Paronetto), 1317
Substances (Plant-Growth), and the Copper Chelating Theory of their Mode of Action (Dr C H Fawcett), 796
N-Substituted 7-Methoxy-8-Aminomethylchromones and Flavones—New Brain-Stem Stimulants (P Da Re, L Verlicchi, Dr I Setnikar, W Murmann and M J Magistretti), 362
2-Substituted Thiadiazoles Reversal of Effects of, by Nicotinamide Analogues and Precursors (Dr Irwin H Krakoff, Corrine R Lacon and Dr David A Karnofsky), 1805
Substituents (Borazole) Intermolecular Distances and Diamagnetic Anisotropy in Crystals as Measures of the Polarity of Benzene and (Dame Kathleen Lonsdale), 1060
Substituted Human Serum Proteins Modifications in Immunological Behaviour, Electrophoretic Mobility and Colourability of (M Steinbuch, Dr J M Fine and A Battistini), 1571
Substituted Phenoxy-Compounds and other Translocated Herbicides Effects of, on the Rhizome of Bracken (Dr Elsie Conway and J A Forrest), 1416
Substitution Aromatic—Nitration and Halogenation (Dr P B D de la Mare and J H Ridd), *review* by Prof M J S Dewar, 925
Substitution at Elements other than Carbon (Sir Christopher Ingold), *review* by Dr R I Reed, 1262
Substrate (Polyphenoloxidase), of the Banana Detection and Identification of the (Dr L A Griffiths), 58
Substrate Damage in Film Thickness Measurement by Beam Interferometry (Prof G David Scott), 354
Substrates (Agar) Maintenance of Parathyroid Tissue Fragments on (Dr John H Wallace, Dr George J Hill, Jean M McCarthy and Dr John R Brooks), 1734
Substrates (O-Phosphorylated and Unphosphorylated Peptide-), suitable for Tryptic Action (Dr D Theodoropoulos, H Bennich and Prof O Mellander), 270
Subudhi, M, and others Propagation of Ultrasonic Waves in Liquids, 352
Succinooxidase (Lung) Effect of Cell-Free Extracts of *Mycobacterium tuberculosis* $H_{37}Rv$ on (Dr A Bekierkunst and M Artman), 458
Sucrose Biosynthesis of some Amino-Acids from, by Germinating Uredospores of Wheat Stem Rust, Race 15*B* (B Kasting, A J McGinnis and W C Broadfoot), 1943
Sucrose Stearate Interaction of, with Starch (Prof E J Bourne, A I Tiffin and Dr H Weigel), 110
Suddaby, Dr A Fluctuation Phenomena and Stochastic Processes (Relation between the Microscopic Theories of Transport Processes developed by Kirkwood and the Macroscopic Theory of Brownian Movement), 511
Sudo, Dr Toshio Mineralogical Study on Clays of Japan, *review* by Dr D M C MacEwan, 1439
Sudperus (Andenabhang) Ein neuer *Asthenes* (Aves Furnariidae) von der Kuste und dem westlichen (Maria Koepcke), (Beitrage zur Neotropischen Fauna), *review* by Dr F A Turk, 1177
Sugai, Sadako, and others Formation of Streptolysin *S* by Streptococcal Protoplasts, 832
'Sugar' Cataract Formation of Polyols by the Lens of the Rat with (Dr Ruth van Heyningen), 194
Sugar Phosphates Periodate Technique for the Identification of (Eugene A Davidson), 1395
Sugar (Blood), and Liver Glycogen Level of Normal and Adrenalectomized Mice Effect of Diet on the (B P Block and Dr G S Cox), 721
Sugars Discrimination of Xylose from Arabinose and some other (B Drozdz), 1395
Sugars of the Glycoside of the Root of *Marsdenia erecta* R Br (Dr T Baytop, Dr M Tanker, Dr N Oner and Dr S Tekman), 1319
Sugars' ('Unnatural) Specific Inhibition of Anti-Rh Serum of (Dr William C Boyd, Marjorie H McMaster and Eugenia Waszczenko-Zacharczenko), 989
Sugawara, Prof K Position and Activities of the Japanese Geochemical Society, 1193
Sugden, Dr T M Reaction Kinetics, *review*, 299
  Free Radicals, *review*, 1259
Suggestions to Authors of the Reports of the United States Geological Survey, fifth edition, *review* by Prof C F Davidson, 390
Sukanya, N K, and Vaidyanathan, C S Biochemical Research in India (Purification and Properties of a Naturally Occurring Inhibitor of Glutamine Synthesis present in *Pongamia* Galls), 1368
Sulebele, G A, and others Pantothenic Acid Deficiency and Ubiquinone Levels in Rat Liver Mitochondria, 1867
Sulkowski, E, and others Cytoplasmic Nucleopeptides in Guinea Pig Liver, 1940
Sullivan, J V At the Second Australian Spectroscopy Conference (Vacuum Spectroscopic Technique—a Double-beam Photoelectric 1m Grating Spectrometer), 1196
Sullivan, Margaret, and others Distribution of 5-Carboxymethylhydantoinase, 1314
Sullivan, R M E (Rose, Dr H E, and) Rapid Estimation of the Specific Surface of a Powder, 46
Sullivan, T, and others A Virus Disease of *Meloidogyne incognita incognita*, the Southern Root Knot Nematode, 1896
Sulphanilamide Effect of, on Citric Acid Production by *Aspergillus niger* (K V Rajagopalan, R Radhakrishnamurthy and P S Sarma), 461
Sulphate Esters (Carbohydrate) Infra-Red Spectra of (Dr G A Lloyd and K S Dodgson), 548
Sulphate (Calcium) Hemihydrate Transition of, to Insoluble Anhydrite (Chikara Mitsuki and Masayoshi Kita), 1481
Sulphates (Chondroitin) Biosynthesis of (J B Adams), 274
Sulphide (Cadmium) Structure of Precipitated, as studied by Single-Crystal Electron Diffraction Pattern (Dr Ryoitiro Sato), 2005
Sulphonamides Effect of, on the Phagocytic Activity of the Reticulo-Endothelial System (Prof T Nicol and I A Sewell), 1241
Sulphonamides with Diuretic Activity (Dr W Logemann, Dr P N Giraldi and Dr M A Parenti), 1711
Sulphonamides (Saluretic) An Antimineralocorticoid Action of some (Dr G C Kennedy and Dr J D Crawford), 1492
Sulphonate (Ethyl Methane) Mutation of Bacteria at High Levels of Survival by (Anthony Loveless and Sheila Howarth), 1780
Sulphonic Acid Stability of Metal complexes of Oxine and its (Prof Adrien Albert and Prof Reino Nasanen), 449
Sulphosuccinate (Dioctyl Sodium) Registration of the Spermicidal Effects of (Prof Per Eric Lindahl and Kjell Wedin), 1289
Sulphur-35 Measurement of the Rate of Growth of Wool using Cystine labelled with (A M Downes and A G Lyne), 1884
Sulphur Bacteria (Red) Amino-Acids of (H Mukherjee), 1742
Sulphur Dioxide Inhalation Influence of, on the Phagocytic Activity of the Macrophage System (Prof D L J Bilbey and Dr H Salem), 722
Sulphydryl (Cystine-Cysteine, Glutathione and Total Free) Contents of in Arsenic-resistant and Sensitive Strains of the Blue Tick, *Boophilus decoloratus* (Dr J S Harington), 1739
Sulphydryl Group in D-Amino-Acid Oxidase Apo-Protein Binding of the, with Flavin Adenine Dinucleotide (Dr Kunio Yagi and Takayuki Ozawa), 1227
Sumatra *Rafflesia arnoldi* in (W Meijer), 506
Sumiki, Yusuke Plant Growth Regulation (Recent Work with the Gibberellins), 600
Summation Visual Spatial and Temporal (Dr Ernest Baumgardt), 1951
Summer School for Science Teachers (Australian Nuclear Research Foundation), 1108
Summer Tanager observed on Bardsey Island, 236
Sumner, Dr W L Science and Literature, *review*, 5
  Stars and Man, *review*, B A 3
  Inside the Living Cell, *review*, 134
  The Two Cultures and the Scientific Revolution, 411
  Science Education, *review*, 923
Sun Lyman-Alpha Photographs of the (J D Purcell, Dr D M Packer and Dr R Tousey), 8
Sunagawa, Dr I Twinning of Crystals (Growth and Natural Etch Patterns observed with a Phase-Contrast Microscope on the Boundaries of Hematite Crystals forming Contact Twins after $(10\bar{1}0)$), 1911
Sundahl, William P (Hellmers, Henry, and) Response of *Sequoia sepervirens* (D Don) Endl and *Pseudotsuga menziesii* (Mirb) Franco Seedlings to Temperature, 1247
Sunigawa, Dr I (Tolansky, Prof S, and) Spiral and other Growth Forms of Synthetic Diamonds—a Distinction between Natural and Synthetic Diamond, 1526
Sunner, S Thermodynamics (Experimental Thermochemistry), 1607

Sunspot Numbers Prediction of, until the End of the Present Cycle (Dr P Herrinck), 51
  Prediction of, for Cycle 20 (Dr W B Chadwick), 1787
Sunspots and Enhanced Radiation on 200 Mc /s Correlation between the Intensity of the Umbra of (Per Maltby), 1391
Sunvic Controls, Ltd To combine with the Instrument and Meter, Scientific Apparatus and X-Ray Departments of Metropolitan-Vickers Electrical Co , Ltd , to form the Instrumentation Division of Associated Electrical Industries, Ltd , 1535
Suolo, Carta della Utilizzazione del Sheets 19 and 20, Calabria (Ferdinando Milone) , Sheets 21, 22 and 23, Sicily (Ferdinando Milone), (Consiglio Nazionale della Richerche, Napoli), 27
Superannuation Difficulties in the Present Systems of, 503
'Supercarbia' in the Anaesthetized Dog (Dr G R Graham, D W Hill and J F Nunn), 1071
Supercontraction and Urea-Bisulphite Solubility Permanent Set,—the Proton-Transfer Nature of some Changes in Keratin and the Analogy with Muscle Contraction (Dr P T Speakman), 339
Supercooling of Water Droplets (P G Fox), 546
Superposition of Crystal Plates between Crossed Polars A Special Case of the, and its Bearing on the Microscopy of Cellulosic Fibres (Dr N H Hartshorne), 179
Supervisors and Managers Management Development, a Systematic Approach to the Provision of (F I de la P Garforth), 319
Supply of Potassium, Calcium and Magnesium Effect on the Groundnut of Variations in (Dr R Comber), 1003
Supply, Ministry of Resignation of Sir Owen Wansbrough-Jones as chief scientist, B A 13
  Promotion of Dr N J L Megson to Deputy Chief Scientific Officer and appointed director of Materials Research and Development (Air), 232
  Promotion of Dr B G Dickins to Chief Scientific Officer and appointed director general of atomic weapons, 232
  Promotion of P A Hufton to Chief Scientific Officer and appointed head of the Aerodynamics Department of the Royal Aircraft Establishment, 233
  Retirement of Dr H Sutton as director of Materials Research and Development (Air), 769
  Appointment of Dr R Cockburn as chief scientist, 938
  Grant not exceeding £1,175 to the University of Oxford, for the continuation of an investigation of fluorocarbohydrates, 943, 1273
  Grant of £1,150 to the Department of Electrical Engineering in the University of Bristol, for research on noise generation in inductors with ferromagnetic cores (continuation of grant), 1613
Supply and Demand (Water), in Great Britain (Prof W G V Balchin), B A 18
Suppression (Immunological) Tumour Specificity and (Elaine Levi, A M Schechtman, Richard S Sherins and Stanley Tobias), 563
Suppression (Pharmacological), of Increased Capillary Permeability following Irradiation of the Intestine of Rats (Dr D A Willoughby), 1156
Surface of the Ocean as a Source of Air-borne Nitrogenous Material and other Plant Nutrients (Dr A T Wilson), 99
Surface (Specific), of a Powder Rapid Estimation of the (Dr H E Rose and R M E Sullivan), 46
Surface-Hardened by Carbo-Nitriding Identification of the High-Temperature Constituent in Mild Steel (M A H Howes, G T F Jay, K Sachs and D Wilkinson), 1312
'Surface Membrane Complex' Dissociation of the, in Atrophic Muscle Fibres (Dr R Birks, Prof B Katz and Dr R Miledi), 1507
Surface Precipitation Reaction A Method for the Quantitative Study of the (Francis T Ashton), 1735
Surface Properties Evidence for a Hydrate of Cellulose from Studies of its (Dr J M Joubert, Dr G J R Krige and Dr K Borgin), 1561
Surface Topography of the Antarctic Ice Sheet (Dr J F Nye), 786
Surface Replication (Fibre), by Rolling (J Mølgaard), 264, 1478 , (H J Woods), 1478
Surface-Water Resources Techniques for Surveying (Prof Ray K Linsley), (World Meteorological Organization, Technical Note No 26), 96, *erratum*, 684
Surfaces Semiconductor (United States Office of Naval Research Second Conference on), 1192
Surfaces (Cathode) Insulating Particles on—their Effect upon Electrical Discharges (L B Griffiths and P C L Pfeil), 1475
Surfaces (Polished Metal) The Nature of (L E Samuels), 1280
Surgery in World War II Neurosurgery, Vol 1 (Colonel John Boyd Coates, editor-in-chief), *review* by J E A O'Connell, 1676
Survey Water-Resources and Water-Use (Dr Alice Garnett), 96, *erratum*, 684
Survey of American and European Working Conditions in Industry Fitting the Job to the Worker—a (European Productivity Agency of the Organization for European Economic Co-operation, Project 335), 422
Survey of Soils in the Kongwa and Nachingwea Districts of Tanganyika (B Anderson), *review* by Dr R M S Perrin, 1901
Survey (Oceanographic), of the Ross Sea (J S Bullivant), 422
Survey (Zoological), of Madagascar (Dr Renaud Paulian), 1387
Surveying Surface-Water Resources Techniques for (Prof Ray K Linsley), (World Meteorological Organization, Technical Note No 26), 96, *erratum*, 684
Surveys in 'Applied' Mathematics, *review* by D G Kendall, 214
Surveys (Air), and the Social Scientist (Leo Silberman), 244
Survival Mutation of Bacteria at High Levels of, by Ethyl Methane Sulphonate (Anthony Loveless and Sheila Howarth), 1780
Survival after a Disaster Food for (Dr R C Hutchinson), *review* by M W Grant, 841
Survival from Experimental Diphtheric Intoxication Effect of Tranquillizing Drugs on (Prof Leo Greenberg and Dr James W Ingalls), 1721
Survival of Frozen Fat Body Cells in an Insect (R W Salt), 1426
Survival of Grasshopper Eggs kept for Long Periods in Mineral Oil (Prof Eleanor H Slifer), 1424
Survival in Intraperitoneal Infections of Mice Opsonins as Determinants of (Dr C R Jenkin and Prof D Rowley), 474
Survival of Spermatozoa following Drying (Dr Harold T Meryman and Emanuel Kafig), 470
Survival of Yeast in Dry and Wet Conditions Effect of X-Radiation on the (A Mookerjee), 1502
Survival (Prolonged), of Dystrophic Mice treated with 17α-Ethyl-19-Nortestosterone (Dr Robert M Dowben), 1966
Susceptibility (Tumour-) Factor in Eggs Differentiation between a Growth-Promoting Factor and a (Charles H Hill and Henry W Garren), 824
Suspected Virus Disease of the Citrus Red Mite *Panonychus citri* (McG), (Dr Kenneth M Smith, G J Hills, F Munger and J E Gilmore), 70
Suspension Effects of the Energy of Strong Pulses of Ionic Current on Micro-organisms in (B S Gossling), 1881
Suspension Stability of Red Blood Corpuscles Effect of Polyphloretin Phosphate on the (Dr Bengt Fries), 62
Suspensions of Parenchymatous Liver Cells Some Enzymatic Properties of (Dr Keith S Henley, Ole Sorensen and H Marvin Pollard), 1400
Sutcliffe, Ltd , Richard Grant of £1,000 to the University of Leeds, for research in mining, 1108
Sutton, Dr D A Appointed director of research of the British Gelatine and Glue Research Association, 318 , work of, 318
Sutton, Dr H Retirement as director of Materials Research and Development (Air) in the Ministry of Supply, 769 , work of, 769
Sutton, Harriet (Elkind, M M , and) X-Ray Damage and Recovery in Mammalian Cells in Culture, 1293
Sutton, Dr Philip R N Association between Colour of the Iris of the Eye and Reaction to Dental Pain, 122
Svet-Moldavskaya, I A , and others Various Types of Acquired Resistance to Experimental 'Allergic' Encephalomyelitis, 1552
Svet-Moldavsky, G J , and others Various Types of Acquired Resistance to Experimental 'Allergic' Encephalomyelitis, 1552
Swainbank, I G , and others Atomic Weight of Silver, 358
Swamp Soil (Uganda) Nitrogen Fixation in a (E A Calder), 746
Swan, J M (Leach, S J , and) Structure and Chemistry of Proteins (Chemistry of Thiols and Disulphides), 1277
Swarming in Bees Electronic Prediction of (E F Woods), 842
Sweat Glands (Cholinergically Innervated) Response of, to Adrenaline and Noradrenaline (Dr David P C Lloyd), 277
Swedenborg Blood Grouping of the Remains of (Madeleine Smith), 867
Swedes Fodder Beet, Mangels and (National Institute of Agricultural Botany Leaflets on), 1777
Sweet, Dr P A Appointed professor of astronomy in the University of Glasgow, 23 , work of, 23
Sweet Cherries (Sour and) Occurrence of Leuco-Anthocyanin in (Dr Kuang C Li), 1935
Sweet Potato Effect of Indole Acetic Acid and α-Naphthalene Acetic Acid on the Growth, Flowering and Fruit Set in (G Satyanarayana and Dr G Rangaswami), B A 73
Swelling of Isolated Mitochondria Effect of Reduced Diphosphopyridine Nucleotide on the (Dr G Di Sabato), *erratum*, 95
Swelling Forces in Straining Clays (E L Greacen), 1695
Swellings on the Shoots of Cacao Plants Deficient in Copper (Dr R G Lockard, P Vamathevan and S Thamboo), 75
Swettenham, Brig N A M (McKenzie, D S , and) Biomechanics (Provision of Workable Substitutes for Missing or Defective Limbs), 513
Swinton, Dr W E Presidential Address at the sixty-fifth Annual Conference of the Museums Association, 597
  Re-elected president of the Museums Association, 598
Swinton, Dr W E , and Allen, Sir George To represent the British Association for the Advancement of Science in a visit to the U S S R , 1271
Swiss Society for Natural Sciences 139th Annual Meeting (Dr R C H Tanner), 1454
  Presidential Address, La science, le savant et le pharmacien (Prof A Girardet), 1454
Sydney (County of Cumberland), New South Wales The Birds of (K A Hindwood and A R. McGill), *review* by Dr A J Marshall, 841
Sykes, Dr J Appointed lecturer in biochemistry at the University of Sheffield, 684
Sykes, Dr M F Fluctuation Phenomena and Stochastic Processes (Methods for the Practical Determination of Parameters in Self-avoiding Walks), 510
Sylven, Dr B (Goldacre, Dr R J , and) A Rapid Method for Studying Tumour Blood Supply using Systemic Dyes, 63
Symbiotic Nitrogen Fixation of Legumes Influence of Temperature on the (the late Prof Margaretha G Mes), 2032
Syme (David) Research Prize of the University of Melbourne awarded to Dr J H Piddington, B A 16
Syme, Ronald Elected an Honorary Member of the American Academy of Arts and Sciences, 410
Symington, Dr Janey, and others Replication of Tobacco Mosaic Virus—Kinetics of Virus Protein and Ribonucleic Acid Biosynthesis, 1992
Symington, R B Light Regulation of Coat-Shedding in a Tropical Breed of Hair Sheep, 1076
Symmons, P M (Gunn, Dr D L , and) Forecasting Locust Outbreaks, 1425
Symmons, Dr S (de Kock, Dr L L , and) A Ligament in the Dorsal Aorta of certain Fishes, 194
Sympathetic Postganglionic Mechanism (Prof J H Burn and M J Rand), 163
Synaptic Function Enhanced, due to Excess Use (Dr Rosamond M Eccles and Dr R A Westerman), 460
Syncarid Crustacea, 1914
Synchrotron Zero Gradient (Argonne National Laboratory), 503
Synchrotron, *Nimrod* (7,000-MeV Proton) Contracts for work on the (National Institute for Research in Nuclear Science), B A 14
Syndrome The Acute Radiation—a Medical Report on the Y-12 Accident, 1958 (compiled by Dr Marshall Brucer), (United States Atomic Energy Commission, Report ORINS-25), 1022
Synge, Dr R L M Awarded a John Price Wetherill Medal of the Franklin Institute, 857
  Structure and Chemistry of Proteins (Naturally Occurring Peptides and their Biological Significance), 1277
Synge, Dr R L M (Carnegie, P R , and) Structure and Chemistry of Proteins (Electrophoretic Behaviour of Cupric Complexes of Oligopeptides), 1277
Syntheses Organic, Vol 37, 1957 (edited by James Cason) , Vol 38, 1958 (edited by John C Sheehan), *review* by Prof John Read, 134
Syntheses (Organic) Use of Isotopes in, *review* by Dr G Eglinton, 1830

Syntheses (Organic), with Isotopes (Arthur Murray, III, and D Lloyd Williams), Part 2, Organic Compounds labelled with Isotopes of the Halogens, Hydrogen, Nitrogen, Oxygen, Phosphorus and Sulfur, *review* by Dr G Eglinton, 1830
Synthesis Protein (Dr P M Bhargava), 1368
Synthesis of *T5* and *T7* Bacteriophages Effects of Deuterium Oxide on the (E L Rothstein, L A Manson, R Hartzell, jun , and David Kritchevsky), 1167
Synthesis of Boron Phosphide and Nitride (Dr R C Vickery), 268
Synthesis of Deoxyribonucleic Acid in Adult *Drosophila* (Per Oftedal), 1961
Synthesis of Diphosphopyridine Nucleotide from Nicotinamide by Slices of Liver (C J Threlfall), 60
Synthesis of Dipicolinic Acid from $\alpha\epsilon$-Diketopimelic Acid (the late Joan F Powell and R E Strange), 878
Synthesis of I-Glycerl-2-*myo*-inositol Phosphate (Synthesis and Properties of I-Glyceryl-2-*myo*-inositol Phosphate), (J H Davies and Dr T Malkin), 789
Synthesis of Haem by Circulating Blood Cells (Peggy Clark and Dr R J Walsh), 1730
Synthesis of Linear Communication Networks (Wilhelm Cauer), second edition edited by Wilhelm Klein and Franz M Pelz (translated from the German by G E Knausenberger), *review*, 1525
Synthesis of Methanol over Zinc Oxide Effect of Gamma-Radiation on the (T I Barry and R Roberts), 1061
Synthesis of a Protected Heptapeptide related to the Histidine Analogue of Hypertensin II (Dr Dimitrios Theodoropoulos), 1634
Synthesis of Proteins in *Escherichia coli* Influence of DL-beta-Phenylserine on the (J Janeček, J Chaloupka, K Vereš and M Havranek), 1895
Synthesis (Actinomycin) Inhibition of, by D-Valine (Prof Edward Katz), 1666
Synthesis (Alternative), and Behaviour on Hydrolysis I-Glyceryl-2-*myo*-inositol Phosphate— (Synthesis and Properties of I-Glyceryl-2-*myo*-inositol Phosphate), (R B Ellis and J N Hawthorne), 790
Synthesis (Chromosomal), of Ribonucleic Acid as shown by Incorporation of Uridine labelled with Tritium (G Pelling), 655
Synthesis (Colour-Image), with Two Unorthodox Primaries (Arthur Karp), 710
Synthesis (Deoxyribonucleic Acid) in *Escherichia coli* 15$_T$ Influence of Unbalanced Growth on subsequent X-Ray Induced Inhibition of (Daniel Billen), 174
Synthesis (Glucosamine) Interfering Substances in the Determination of (Dr Fiorenzo Paronetto), 1317
Synthesis (Haemoglobin) Role of Stroma in—Experiments on Duck Red Cells *in vitro* (A Breccia, A L Fantola, E Lazzarini and A Giustina), 1878
Synthesis (Haemoglobin), in De-embryonated Chick Blastoderm 8-Azaguanine Inhibition of (B R A O'Brien), 376
Synthesis (*in vitro*) of Acetylcholine Effect of Pempidine on the (Joan Parkinson), 554
Synthesis (Introductory), of Zoogeography, Phytogeography and Geology Panbiogeography, or an (Dr Léon Croizat), Vol 1, The New World , Vol 2a, The Old World , Vol 2b, The Old World (continuation), *review* by Prof Ronald Good, 924
Synthesis (Macromolecular), in Bacterial Recovery from Ultra-violet Light (C O Doudney), 189
Synthesis (Protein) Effect of Protein Depletion on the Distribution of (Dr John Waterlow), 1875
Synthesis (Protein), in Macrophages containing *Eimeria tenella* (Dr G A Gresham and J G Cruickshank), 1153
Synthesis (Protein), in *Mycobacterium smegmatis* Effect of Iron and Zinc on Nucleic Acid and (Frank Winder and Joan M Denneny), 742
Synthesis (Ribonucleic Acid), in *Staphylococcus aureus* Selective Inhibition of, by Vancomycin (Prof D C Jordan and W E Inniss), 1894
Synthesis and Properties of I-Glyceryl-2-*myo*-inositol Phosphate (Dr T Malkin), 789 , Synthesis of I-Glyceryl-2-*myo*-inositol Phosphate (J H Davies and Dr T Malkin), 789 , I-Glyceryl-2-*myo*-inositol Phosphate—Alternative Synthesis and Behaviour on Hydrolysis (R B Ellis and J N Hawthorne), 790
Synthesize Adrenocorticosteroids *in vitro* Failure of Corpuscles of Stannius from Winter Flounder (*Pseudopleuronectes americanus*) to (Dr J G Phillips and Dr P J Mulrow), 558
Synthesize Deoxyribonucleic Acid Cells which, in Guinea Pig Bone Marrow during Recovery from Whole-Body γ-Irradiation (P F Harris and J H Kugler), 1883
Synthetic Diamond (Natural and) Spiral and other Growth Forms of Synthetic Diamonds—a Distinction between (Prof S Tolansky and Dr I Sunagawa), 1526
Synthetic Diamonds Spiral and other Growth Forms of—a Distinction between Natural and Synthetic Diamond (Prof S Tolansky and Dr I Sunagawa), 1526
Synthetic Drugs Chemistry of (May's), revised and rewritten by Dr G Malcolm Dyson, in consultation with Dr Percy May, fifth edition, *review* by F R Batchelor, 1597
Synthetic Medium *In vitro* Cultivation of Blood Cells of *Drosophila melanogaster* in a (Dr Masakatsu Horikawa and Dr Yukiaki Kuroda), 2017
Synthetic Polyglucoses Reduction of Toxicity of Cationic Macromolecules by Complexing with Anionic Derivatives of (P T Mora, B G Young anf M J Shear), 431
Synthetic Polypeptides Immunochemical Studies of Polypeptidyl Proteins and (Prof M A Stahmann, D J Buchanan-Davidson, Dr C Lapresel and Dr P Grabar), 549
Syrett, P J Title of reader in botany in the University of London (at University College) conferred on, 1451
System bringing about Oxidative Phosphorylation in *Azotobacter vinelandii* Fractionation of the (H G Hovenkamp), 471
System (Blood Coagulating), and the Physiological Anticoagulating System Interrelations between the (Prof P A Kudrjashov), 454
System (Cytochrome), of *Streptomyces* (Dr E Niederpruem and Dr D P Hackett), 1954
System (Macrophage) Assessment of the Phagocytic Activity of the (Prof D L J Bilbey and Dr H Salem), 992
  influence of Sulphur Dioxide Inhalation on the Phagocytic Activity of the (Prof D L J Bilbey and Dr H Salem), 722
System (Near Infra-Red), of Nitrogen (Dr P K Carroll and Dr H E Rubalcava), 119
System (Nickel–Oxygen) 'Thermal Regeneration' in the (Prof J S Anderson and D F Klemperer), 899
System (Physiological Anticoagulating) Interrelations between the Blood Coagulating System and the (Prof P A Kudrjashov), 454
System (Tryptophan Peroxidase-Oxidase Enzyme) Specificity of the (Dr R H Marchant), 1711
System (Two-Dimensional), for the Separation of Amino-Acids and Peptides on Paper (Virginia Richmond and Brian S. Hartley), 1869
Systematic Mineralogy of Uranium and Thorium (Prof Clifford Frondel), *review* by Prof C F Davidson, 576
Systematic Pragmatics Toward a (R M Martin), *review* by F I G Rawlins, 754
Systematics Applications of Paper Chromatography to—Recombination of Parental Biochemical Components in a *Baptisia* Hybrid Population (Dr R E Alston and Dr B L Turner), 285
Systeme du Monde Le—Histoire des Doctrines Cosmologiques de Platon a Copernic (Prof Pierre Duhem), Tome 10, *review* by Prof E J Dijksterhuis, 836
Systemic Dyes A Rapid Method for Studying Tumour Blood Supply using (Dr R J Goldacre and Dr B Sylven) 63
Systems (*d*-Amino-Acid Oxidase) Effect of Chlorpromazine upon Isolated (Dr Andrew Lasslo and Anne L Meyer), 1922
Systems (Aqueous) Solid State Rheological Study of the Mechanism of Paraffin-Detergent Interactions in (F J Radd and L H Crowder), 443
  Strength Impairment Mechanism of Glass in (Frederick J Radd and Donald H Oertle), 976
Systems (Aqueous Polymer Phase) Counter-Current Distribution of Proteins in (Per Åke Albertsson and Ed Jacques Nyns), 1465, *erratum*, 1688
Systems (Binary) Estimation of the Interchange Energy for, from Mutual Solubility Data (Kiyoharu Ishida), 814
Systems (Biochemical Assay), involving Nitrite Estimation by Diazotization Measurement of Inhibition by Azide in (Dr E J Hewitt and D G Hallas), 1485
Systems (Biological) Energy Transfer with special reference to (Faraday Society Discussion on), 688
  Flow Properties of (Colloid and Biophysics Committee of the Faraday Society and the British Society of Rheology Discussion on), 1539
Systems (Biological Assay) Interference by Azide with Diazotization Procedures used in (J R Villanueva), 549
Systems (Conjugated) Steric Effects in—Proceedings of a Symposium held at the University, Hull, 1958, by the Chemical Society (edited by Dr G W Gray), *review* by Dr G Eglinton, 1522
Systems (Dispersed) Dielectric Absorption in (G A Johnson and Dr S A Neale), 898
Systems (Gas–Liquid) Droplet Circulation and Interfacial Disturbances in (Dr C Ramshaw and Dr J D Thornton), 719
Systems (Haematin) in Cheese Fat Oxidation and (Tallowy Discoloration in Cheddar Cheese), (C G Rammell), 1296
Systems (Liquid Crystal), from Fibrillar Polysaccharides (R H Marchessault, F F Morehead and N M Walter), 632
Systems (Living) Self-Regulation in (Second Ottawa Symposium on), 239
Systems (Mitochondrial Enzyme) Effect of some Neuromuscular Blocking Agents on (Dr J H Koch and Dr C H Gallagher), 1039
Systems (Present), of Superannuation Difficulties in the, 503
Systems (Suitable Buffer), for Counter-current Distribution A Paper-Chromatographic Method for the Determination of (Andrzej Waksmundzki and Edward Soczewinski), 977
Szabolcsi, G (Elodi, P , and) Role of the Co-enzyme in the Stabilization of Glyceraldehyde-3-phosphate Dehydrogenase, 56
Szafranski, P , and others Cytoplasmic Nucleopeptides in Guinea Pig Liver, 1940
Szczepkowski, Tadeusz W and others Thiosulphate Metabolism in the Animal Organism, 994
Szegvari, Gy , and others Thermoregulatory Heat Production in the Brain, 993
Szekacs, Dr I (Ladik, J , and) A Micro-method for the Polarographic Determination of Serine, 188
Széll, Dr T , and Furka, A A New Method for Working up Processing Mixtures containing Anhydrous Aluminium Chloride, 117, *erratum*, 595
Szent-Gyorgyi, Dr A Energy Transfer with special reference to Biological Systems (Energy Migration in Biological Systems), 689
Szentirmai, A (Horvath Dr I , and) Inhibitory Effect of Fungistatic Antibiotics on the Production of Amylase by *Penicillium chrysogenum*, 57
Szentirmai, A , and others A New Trichothecin-like Antifungal Antibiotic, 908
Szewczyk, J (Durie, R A , and) Coal Science (Spectroscopy of Coals—Light Spectroscopy), 413
Szigeti, B Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 157
Szilard, Prof Leo A Theory of Ageing, 957
Szilard-Chalmers Process in Solids Influence of Crystal Defects on the (Dr A G Maddock and J I Vargas), 1931
Szilard-Chalmers Reaction in Lithium Permanganate (J R Bolton and Prof K J McCallum), 1717
Szwarc, M Macromolecules (Anionic Polymerization), 1689

TABLES (Thermodynamic) Polynomial Representation of (Prof C J Pings), 444
Tabor, Dr D , and others Friction in Textiles, *review*, 1765
Tabular Comparative Data for the Low- and High-Temperature Strains of *Chlorella* (Dr Constantine Sorokin), 613
Taeschler, Dr M , and Cerletti, Dr A Differential Analysis of the Effects of Phenothiazine-Tranquillizers on Emotional and Motor Behaviour in Experimental Animals, 823
Taft's Constants σ^* An Attempt at Calculating the (Rudolf Zahradnik), 1865
Taggart, Nan, and Hytten, Dr F E Saliva-Serum Ratios of Deuterium Oxide after Administration of Heavy Water, 457
Tail Tendon Collagen (Rat) Chromatographic Fractionation of (Alexander Kessler, Hyman Rosen and Dr Stanley M Levenson), 1640

Tait, Dr J B, and Martin, J H A Polar Front Survey (Hydrography—Volume Transport through the Faroe-Shetland Channel), 1181
Tait, Dr J F, and others 3,4,ω-Tri-hydroxyacetophenone 3-methyl Ether in Adrenal Extracts, 268
Tait, P J T Awarded a General Fellowship in Chemistry for 1959-60 by the Ramsay Memorial Fellowships Trustees, B A 16
Tait, Dr S A S, and others 3,4,ω-Tri-hydroxyacetophenone 3-methyl Ether in Adrenal Extracts, 268
Takagi, Dr S F, and Shibuya, Dr T 'On'-and 'Off'-Responses of the Olfactory Epithelium, 60
Takagi, Dr Yasuyuki, and others Induction of Phage Formation in the Lysogenic *Escherichia coli* K-12 by Mitomycin C, 1079
Takeo, K, and others Proof of the Formation of Enzyme-Substrate Complex by 'Crossing-Paper Electrophoresis', 638
Talanta Medal for outstanding contributions to analytical chemistry, 856
Talbot, Dr A Modern Network Theory in Electrical Engineering (Use of Tchebyscheffian Approximations in Network Synthesis), 1692
Tallowy Discoloration in Cheddar Cheese—Fat Oxidation and Trace Metals in Cheese (F Bishop), 1295, Fat Oxidation and Haematin Systems in Cheese (C G Rammell), 1296
Tamaoki, Taiki, and others Oxidative and Phosphorylative Activities of Cytoplasmic Particles from Plant Tissue Cultures, 1491
Tamarind A New Enzyme System in the (D Mukherjee and N A Khan), 1140
Tamaulipas (Sierra de), Mexico Preliminary Archaeological Investigations in the (Dr Richard S MacNeish), 593
Tamm, K Fast Chemical Reactions in Solution (Use of the Sonic Relaxation Method for Rate Measurements in Water Solutions), 1453
Tanager (Summer), observed on Bardsey Island, 236
Tandem Generators of the United Kingdom Atomic Energy Authority (K W Allen, F A Julian, W D Allen, A E Pyrah and J Blears), 303
Tandon, Dr S L, and Mzalik, C P Intraspecific Polyploidy and Evolution of Diverse Morphological Forms in *Convolvulus pluricaulis* Chois, 481
Tanganyika Soils of, *review* by Dr R M S Perrin, 1901
  Summary of the Geology of, Part 1, Introduction and Stratigraphy (A M Quennell, A C M McKinlay and W G Aitken), 1688
  A Survey of Soils in the Kongwa and Nachingwea Districts of (B Anderson), *review* by Dr R M S Perrin, 1901
Tanganyika Expedition University of Oxford Second (R Davis), 1543
Tanganyika Geological Survey Memoir No 1, Summary of the Geology of Tanganyika, Part 1, Introduction and Stratigraphy (A M Quennell, A C M McKinlay and W G Aitken), 1688
Tanker, Dr M, and others Sugars of the Glycoside of the Root of *Marsdenia erecta* R Br, 1319
Tanned Erythrocytes in the Rabbit Production of an Agglutinating Auto-Antibody (Panagglutinin) Active upon (P O Hubinont, P Ghysdael and O Thys), 1250
Tanner, Dr R C H Swiss Society for Natural Sciences, 1454
Tanner, R I Biomechanics (Tests on 'Fluon' as a Material for Artificial Animal Joints), 513
Tannin Effect of Ultrasound on the Protein of Human Serum Denatured with (Dr Wizold Mizgalski and Irena Zygmunt), 1486
Tannins (Vegetable) The Chemistry of—Being the Papers presented at a Symposium held in the University, Cambridge, 1956, under the auspices of the Society of Leather Trades' Chemists, *review* by Dr A I Scott, 1832
Tape From Tinfoil to—the History of the Gramophone (John Cain), 1535
Tardif, H P, and Chollet, P Dynamic and Static Deformation of Armco Iron, 1917
Target Volume of Enzyme Induction X-Ray Sensitivity and (Dr Helmut Pauly), 1570
Tarkowski, Dr Andrzej K Experiments on the Development of Isolated Blastomeres of Mouse Eggs, 1286
Tarnoky, Dr A L Clinical Biochemical Method, *review* by Dr D S H W Nicol, 576
Tasaki, Dr I Resting and Action Potentials of Reversed Polarity in Frog Nerve Cells, 1574
Tasmania and Macquarie Island Transport of Driftwood from South America to (Prof H N Barber, Dr H E Dadswell and H D Ingle), 203
Tata, Sir Dorabji Jamsetji (1859-1932), 591
Tata Memorial Trust Awards for Research on Leukaemia and allied Diseases, 507
Tau-Meson Decay of a, Underground (A M Short), 893
Taverne, Janice, and Wildy, Peter Purification of Herpes Simplex Virus by Chromatography of Calcium Phosphate, 1655
Tavernier, P, and Boisson, J Chemistry of Propellants (Solid Propellants—Composite Forms), 779
Taxation of Learned and Professional Societies in Britain, 1343
Taxonomic Position of *Arthrobacter* (Dr C S Cummins and Dr H Harris), 831
Taxonomic Revision of the Spotted Skunks of the Genus *Spilogale* (R G Van Gelder), 1024
Taxonomy in the Dipterocarpaceae Chemistry and (Dr E C Bate-Smith and Dr T C Whitmore), 795
Taxonomy of Eucalyptus Floral Morphology and the (Dr D J Carr and S G M Carr), 1549
Taxonomy and Genetics of *Oenothera* (Prof R Ruggles Gates), *review* by Dr W B Turrill, 1974
Tayler, J C A Relationship between Weight of Internal Fat, 'Fill', and the Herbage Intake of Grazing Cattle, 2021
Tayler, R J Thermonuclear Research, 1017
Taylor, Prof Angus E Introduction to Functional Analysis, *review* by Prof T A A Broadbent, 666
Taylor, Dr D M Behaviour of Zinc and Radiozinc in Tumour-bearing Rats, 1649
Taylor, E Openshaw (edited by) Nuclear Reactors for Power Generation, *review* by R Vaux, 301
Taylor, Dr George (edited by) Index Kewensis, Supplementum Duodecimum, 1951-1955, *review* by Prof T G Tutin, 129
Taylor, G N (Evans, J V, and) Radio Echo Observations of Venus, 1358
Taylor, H F, and Wain, Prof R L α-Oxidation of Indoleacetonitrile, 1142
Taylor, Dr J Elected an honorary member of the Institution of Mining Engineers, 1845
Taylor, J C, and others Crystallographic Studies of the Biuret Reaction, 707
Taylor, Dr J C M A New Introduction to Geology, *review*, 1175
  Précis de Pétrographie, *review* 1677
Taylor, Monica Biology of *Amoeba*, 1371
Taylor, R H Age Determination in Wild Rabbits, 1158
Taylor, Dr T H C *Obituary* of J T Davey, 1104, *obituary* of H J Morris, 1104
Taylor Electrical Instruments, Ltd 'Taylormeter Model 100A', a New Multi-range Voltmeter, 1026
'Taylormeter Model 100A', a New Multi-range Voltmeter (Taylor Electrical Instruments, Ltd), 1026
Tea (Cultivated) Top Growth of (Dr D N Barua), 1424
Teachers (Science) Summer School for (Australian Nuclear Research Foundation), 1108
Teaching (Science) French Journal of, 593
Teaching (Statistics) Trends in, *review* by J Durbin, 1008
Teaching Technologists and Technicians Sandwich Courses for (Dr P F R Venables), *review*, 1437
Teale, F J W (Weber, Dr G, and) Energy Transfer with special reference to Biological Systems (Energy Transfer in the Haem Proteins), 689
Tecce Giorgio (Frontali, Laura, and) Enzymic Conversion of L-Rhamnulose to L-Fuculose in *Escherichia coli*, 1315
Technical Books Recent Scientific and, Supp v, July 25, Supp iv, August 29, Supp v, September 26, Supp iv, October 31, Supp vi, November 28, Supp iv, December 26
Technical Books sponsored by the United States Atomic Energy Commission, 407
Technical Colleges Relationship between Industry and (Liverpool District of the Federation of British Industries Conference on), 1690
Technical Co-operation Partnership for Progress—International (Annals of the American Academy of Political and Social Science, May 1959), *review* by R Brightman, 1673
Technical Digests Publication of to be resumed by the Department of Scientific and Industrial Research, 410
Technical Organization Industrial (Institute of the Rubber Industry Conference on), 322
Technical Personnel Scientific and (United States National Science Foundation to establish and maintain a Programme of National Information on), 592
Technical Persons (Scientific and) Registration of (1958), 854
Technical Research (Scientific and), in Britain Organization of, 1255
Technical Writer (J W Godfrey and G Parr), *review* by A L Bacharach, 1749
Technical and Vocational Education in the U S S R (M I Movšovič), 504
Technicians Sandwich Courses for Teaching Technologists and (Dr P F R Venables), *review* 1437
  Technologists and, *review*, 1437
Technicians (Laboratory) Regional Training Course for (University Institute of Chemistry, Lahore), 857
Technique A Fractional Micro-sublimation (W H Melhuish), 1933
  Histochemical (Dr W G Bruce Casselman), *review* by Dr T Kerr, 752
Technique of Lysimetry Effects of Forest Areas on Water Resources, and the—Water and Woodlands (Dr L Leyton), 1184, Lysimeters (F W Green), 1186
Technique (Flash) Primary Processes indicated by the (Reductive Photobleaching of Eosine) (Shunji Kato and Masao Koizumi), 1620
Technique (Humane Experimental) The Principles of (Dr W M S Russell and R L Burch), *review* by Prof M Weatherall, 1675
Technique (Improved), for Intravenous Injection of Newborn Rats and Mice (N F Anderson, E J Delorme, Prof M F A Woodruff and D C Simpson), 1952
Technique (New), for Isolating and Cloning Cells of Higher Plants (Ludwig Bergmann), 648
Technique (Periodate), for the Identification of Sugar Phosphates (Eugene A Davidson), 1395
Technique (Rapid Infra-Red) Over-Exposure Analysis of Organic Compounds in the Blood by a (Dr R D Stewart, D S Erley, T R Torkelson and C L Hake), 192
Technique (Simple Observational) Value of a, for Determining the Fat Content of Algal Cells (Dr J H Evans), 1737
Techniques Blood Group Methods and, *review* by Dr R A Zeitlin, 130
Techniques for Surveying Surface-Water Resources (Prof Ray K Linsley), (World Meteorological Organization, Technical Note No 26), 96, *erratum*, 684
Techniques (Electron Bombardment) Electron Bombardment Floating-zone Melting and allied (Services Electronics Research Laboratory Symposium on), 690
Techniques (Experimental) Structure Analysis and (Institute of Physics Conference on), 857
Techniques (Experimental), in Low-Temperature Physics (Guy Kendall White), *review* by Prof J F Allen, 1260
Techniques (New), in the Analysis of Noise and Vibration (Acoustics Group of the Physical Society and the Institute of Physics Symposium on), 415
Techniques (New), in High Polymer Chemistry (Bradford Institute of Technology Course in), 1845
Techniques (New), in Packaging, *review* by Dr V G W Harrison, 1437
Techniques (Statistical) Principles of (P G Moore), *review* by W J Langford, 1523
Technological Change Personnel Management and (Institute of Personnel Management Annual Conference), 1614
Technological Education in Britain, 94
Technological Education, London and Home Counties Regional Advisory Council for Tenth Annual Report, 94
Technologists The Education of (Prof A J Murphy), 514
Technologists and Technicians, *review*, 1437
  Sandwich Course for Teaching (Dr P F R Venables), *review*, 1437
Technology Electron, *review* by Dr D A Bell, 83
  Electron Physics and (Dr J Thomson and E B Callick), *review* by Dr D A Bell, 83
  A History of (edited by Dr Charles Singer, Dr E J Holmyard, Dr A R Hall and Trevor I Williams), Vol 5, The Late Nineteenth Century, *review* by Dr Leonard Carmichael, B A 5
  Impact of Science and, on Humanism, 1595
  Parliamentary Responsibility for Science and, 1190

Technology Glass (Society of Glass Technology), 855
Technology (Glass), at Sheffield, 1271
Technology (Iron and Steel), in China The Development of (Dr Joseph Needham), *review* by Prof F C Thompson, 1830
Technology (Nuclear), and the Scholarly Tradition, *review* by Dr J Walker, 1973
Technology (Nuclear Reaction) Analytical Chemistry in (Third Conference on), 26
Technology (Rubber) Annual Report on the Progress of (edited by Dr T J Drakeley), (Institution of the Rubber Industry), 854
Technology (Science and), National Lending Library for Appointment of a Consultative Committee, 1449
Technology (*Soviet*), *Digest of*, No I (Engineering Information Services, Ltd), 320
Technology (Vacuum Science and), Joint British Committee for Formation of a, 1191
Technology (Western) A History of (Friedrich Klemm), translated from the German by Dorothea Waley Singer, *review* by K R Gilbert, 1601
Technology and Engineering Man the Maker—a History of (Prof R J Forbes), *review* by Dr A R Hall, 921
Tectonics in the U S S R , 942
Teeth (Incisor), of Rats deficient in Vitamin E Curative Effect of Selenium upon the (Prof J T Irving), 645
Teeth (Sheeps') Cause of Wear in (Dr G Baker, Dr L H P Jones and I D Wardrop), 1583
Tegart, W J M Appointed a lecturer in metallurgy at the University of Sheffield, 684
Tegmental Nuclei A Heat-Loss Mechanism involving the Habenular, Interpeduncular and Dorsal (B G Cragg), 1724
Teichoic Acid from the Walls of *Bacillus subtilis* Structure of (Teichoic Acids from Bacterial Walls), (J J Armstrong, Prof J Baddiley and Dr J G Buchanan), 248
Teichoic Acids from Bacterial Walls—Composition of Teichoic Acids from a Number of Bacterial Walls (J J Armstrong, Prof J Baddiley, Dr J G Buchanan, A L Davison, M V Kelemen and F C Neuhaus), 247 , Structure of Teichoic Acid from the Walls of *Bacillus subtilis* (J J Armstrong, Prof J Baddiley and Dr J G Buchanan), 248
Teichoic Acids from a Number of Bacterial Walls Composition of (Teichoic Acids from Bacterial Walls), (J J Armstrong, Prof J Baddiley, Dr J G Buchanan, A L Davison, M V Kelemen and F C Neuhaus), 247
Teitel, P , and others Loss of Plasticity of Erythrocytes coated with Incomplete Antibodies, 1808
Tekman, Dr S , and others Sugars of the Glycoside of the Root of *Marsdenia erecta* R Br , 1319
Telegraph Service (Inland), Advisory Committee on the Report of the, 1191
Telemetry (Radio-) of Nerve Action Potentials Amplitude-Modulation (Roger M Morrell), 1129
Telescope (Radio) The Ohio State University 360-ft (Prof John D Kraus), 669
Telescope (Radio), for Australia, 93
Television Colour (G G Gouriet), 1535
  Future of Broadcasting and, 1747
Telluric Origin of the Whistler Medium (Dr Francis S Johnson), 1787
Telluride (Bismuth), and related Compounds Stoichiometry of (G Offergeld and J van Cakenberghe), 185
Tellurium in Bismuth Some Semiconductive Properties of Dilute Binary Solid Solutions of Bismuth in Tellurium and (Dr Tomasz R Piwkowski), 355
Temperature Effect of, on the Rate of Setting of Gypsum Plaster (M J Ridge), 47
  Influence of, on the Symbiotic Nitrogen Fixation of Legumes (the late Prof Margaretha G Mes), 2032
  Response of *Sequoia sepervirens* (D Don) Endl and *Pseudotsuga menziesii* (Mirb) Franco Seedlings to (Henry Hellmers and William P Sundahl), 1247
  Spin (Prof A Abragam), 954
Temperature required for Nuclear Reactions in Cosmical Electrical Discharges (Dr C E R Bruce), 2004
Temperature (Body), in Hibernating Bats Endogenous Rhythms of (Prof Michael Menaker), 1251
Temperature (Extremely Low) Prefreezing as a Method enabling Animals to survive Freezing at an (Eizo Asahina), 1003
Temperature (High-) Constituent in Mild Steel Surface-Hardened by Carbo-Nitriding Identification of the (M A H Howes, G T F Jay, K Sachs and D Wilkinson), 1312
Temperature (High-) Gas Jet Blunt-Nosed Bodies in a (F R Sedlund and Prof C C Chang), 812
Temperature (Low), in Rice Plants Quantitative Changes in γ-Aminobutyric Acid induced by (F Zsoldos), 280
Temperature (Low-) Autoradiography for the Detection of Tritium in Tissue, with Removal of Luminescence induced by Tritium (P Pellerin, P Fallot, M Laine-Boszormenyi and F Serrel), 1385
Temperature (Low-) Chars Smoke Emission from Coal and (Studies of Coal), (D Finch), 426
Temperature (Low-) Engineering, *review* by Dr G G Haselden, 1174
Temperature (Low-) Physics Experimental Techniques in (Guy Kendall White), *review* by Prof J F Allen, 1260
Temperature (Low- and High-), Strains of *Chlorella* Tabular Comparative Data for the (Dr Constantine Sorokin), 613
Temperature (Room) Paper Chromatography of Corticosteroids at (J Tuzson), 1937
Temperature Variation of the Principal Magnetic Moments of the Co^{++} Ions and the Asymmetry of the Crystalline Electric Field in Cobalt Acetate Tetrahydrate (Dr Bhagawati Charan Guha), 50
Temperatures Extremely High (Electronics Research Directorate of the United States Air Force Cambridge Research Center Conference on, Boston, 1958), (edited by Dr Heinz Fischer and Lawrence C Mansur), *review* by Dr T E Allibone, 83
Temperatures of Ancient Seas Determination of, by the Measurement of the Oxygen Isotopes Ratio in Fossil Calcareous Organism, (Y A Birstein), 1025
Temperatures in Polar Ice Caps (Dr Uwe Radok), 1056
Temperatures (Low) Photochemical and Stereochemical Properties of Carotenoids at (Staff of the Biological Laboratories of Harvard University)—Photochemical Behaviour of Retinene (Dr Lawrence Jurkowitz), 614 , *Cis-trors* Isomerism and Steric Hindrance (John N Loeb, Paul K Brown and Prof George Wald), 617 , Discussion (Prof George Wald), 620
Tempering The Phenomena occurring in Steels during Quenching and (Academician G V Kurdjumov), 1460
Temple, Prof G Turning Points in Physics (From the Relative to the Absolute), *review* by G R Noakes, 1090
Templeton, W L (Saddington, K , and) Disposal of Radioactive Waste, *review*, 301
Temporal Adaptation to Spatial Detail Vision Measurements of (A J Seyler and Z L Budrikis), 1215
Temporal Summation Visual Spatial and (Dr Ernest Baumgardt), 1951
Ten Years of Ergonomics (Alec Rodger), B A 20
Tendon Collagen (Rat Tail) Chromatographic Fractionation of (Alexander Kessler, Hyman Rosen and Dr Stanley M Levenson), 1640
Tenenbaum, Dr Esther Appearance of Crystalline Needles in Monkey Kidney Cell Cultures infected with Poliomyelitis Virus and Incubated at 22°-30°C , 1657
Tennent, Dr R M Theoretical Physics, *review* 1832
Tension in a Ligament Does an Increase in the, elicit Reflex Muscular Responses? (Dr Bertil Stener), 1495
Tension (Oxygen) Effect of on Haem and Porphyrin Biosynthesis (J E Falk, R J Porra, Ann Brown, F Moss and Helen E Larminie), 1217
ter Haar, Dr D Turning Points in Physics (The Quantum Nature of Matter and Radiation), *review* by G R Noakes, 1090
ter Horst, D Th J , and others Ionization Phenomena in Gases (Post-arc Behaviour of two Practical Circuit Breakers), 1355
Terayama, Prof Hiroshi, and others Incorporation of N-Methyl Carbon of Monoethylaminoazobenzene into Polar Dyes, 1460
Terenin Prof A , and others Energy Transfer with special reference to Biological Systems (Properties of Isolated Chlorophyll), 690
Term Retentate, a New Scientific (E G Turner and J G Feinberg), 1139
Terminal Peptide Sequence of Human Haemoglobin ? (Dr J A Hunt and Dr V M Ingram), 640
N-Terminal Amino-Acids of α-Casein (Dr W Manson), 1393
Termite Fauna (Indian) New Neotropical Element (*Anoplotermes*) in (Dr M L Roonwal and O B Chhotani), 1967
Terpenes The (the late Sir John Simonsen and Dr W C J Ross), Vol 5, The Triterpenes and their Derivatives, *review* by Prof A J Birch, 302
Terpenoids The Higher (P de Mayo), (The Chemistry of Natural Products, Vol 3), *review* by Prof A J Birch, 754
Territories (Underdeveloped) Management and (Political and Economic Planning, Broadsheet No 434), 483
Territories (Under-developed), and their Problems, 1519
Teskey, Dr Benjamin J E (Shoemaker, Dr James S , and) Tree Fruit Production, *review* by Prof H W Miles, 487
Tessari, L , and Parrini, L Glutamic-Pyruvic Transaminase in Rabbit's Long Bones, 904
Test (New Experimental), of Special Relativity (J P Cedarholm and Prof C H Townes), 1350
Test (Rapid and Simple Pathogenicity), for Detecting Virulent Clones of *Fusarium oxysporum* f *cubense* using Seedlings of *Musa balbisiana* (Dr R H Stover), 1591
Test Explosions in Britain Underground, 1532
Test Method (Soil Block), for Timber Limitations Imposed by some Water-borne Preservatives on the (A J McQuire), 1430
Testament (Old) The Value of π and the (Dr J Heading), 78
Testing (Non-Destructive) International Conference on, 1107
Tests (Atomic) Effect of, on Radio Noise (C A Samson), 538
Tests (Creep), on Antarctic Glacier Ice (Malcolm Mellor), 717
Tests (Experimental), of Quantum Electrodynamics (Prof W E Lamb), 954
Tests (Nuclear Weapon), and the Accident at Windscale Accumulation of Radioactive Iodine in Thyroid Glands subsequent to (Dr Hamish A Robertson and Ian R Falconer), 1699
Tests (Spot), for Steroids applied on Paper Use of Porter–Silber and Schiff Reagents as, and their Application to the Study of Rat Adrenal Lipids (Dr Marion K Birmingham), B A 67
Tetra-acetate (Ethylenediamine) Effect of, on Vitamin B_{12} Absorption in the Rat (Edward G Rice, Dr Samuel M Greenberg, John F Herndon and E J Van Loon), 1948
Tetrachloride (Carbon) Effects of, on Kidney and Liver Function in the Sheep (Dr B P Setchell), 1242
  Prophylaxis of Poisoning by (C H Gallagher and R A Simmonds), 1407
Tetracycline Inhibition of Skeletal Formation in the Chick Embryo following Administration of (Gerrit Bevelander, Hiroshi Nakahara and Gloria K Rolle), 728
Tetrahydrate (Cobalt Acetate) Temperature Variation of the Principal Magnetic Moments of Co^{++} Ions and the Asymmetry of the Crystalline Electric Field in (Dr Bhagawati Charan Guha), 50
Tetrahydro-1-naphthoic Acids (5- and 8-Halogeno- Dihydro- and) Plant Growth Activities of (Toshio Fujita, Sadao Imai, Koichi Koshimizu, Tetsuo Mitsui and Jiro Kato), 1415
Tetrapyrrole Side-Chains Selective Oxidation of (J Barrett and P Clezy), 1988
Texas Instruments, Inc Appointment of Dr F Kenneth Brasted as administrative director of the Central Research Laboratory, 26
Textile Chemistry Recent Developments in (Bradford Institute of Technology, the Bradford Chemical Society and the Yorkshire Council for Further Education Symposium on), 1845
Textile Industry's Research Association (Ahmedabad 160
  Proceedings of the Fifth Management Conference (1959), 1913
Textile Institute Warner Medal awarded to Dr Margaret Hannah, 26
  Service Medals awarded to Walter Garner and Dr A R Urquhart, 156
Textile Institute (Physics Group) Inaugural Meeting and Conference, B A 16
Textile Institute (Quality Control Group) Conference on Quality Control, B A 16
Textiles Friction in (Dr H G Howell, K W Mieszkis and Dr D Tabor), *review*, 1765
Textiles and Dyes at the University of Leeds, 155
Thalassaemia Diseases Genetic Basis of the (Prof V M Ingram and A O W Stretton), 1903

Thamboo, S , and others Swellings on the Shoots on Cacao Plants Deficient in Copper, 75
Theobroma cacao L in Ghana New Pests of Cocoa, following Applications of Insecticides (P F Entwistle C G Johnson and E Dunn), 2040
Theodoropoulos, Dr D Synthesis of a Protected Heptapeptide related to the Histidine Analogue of Hypertensin II, 1634
Theodoropoulos, Dr D , and others Action of Trypsin on α-Carbethoxy-L-lysyl-L-serylglycine and its O-Phosphorylated Analogue, 187
O-Phosphorylated and Unphosphorylated Peptide-Substrates suitable for Tryptic Action, 270
Theoretical Confusion Function A Mathematical Model for Perception and a (M Hammerton), 1668
Theoretical Mechanics at Southampton, 590
Theoretical Physics (Prof F Woodbridge Constant), *review* by Dr R M Tennent, 1832
Theoretical Physics at Cambridge Applied Mathematics and, 686
Theoretical Physics at Sydney, 1447
Theoretical and Applied Mechanics (Indian Society of Theoretical and Applied Mechanics Fifth Congress on), 1192
Theoretical and Applied Mechanics, Indian Society of Fifth Congress on Theoretical and Applied Mechanics, 1192
Theorie der Phanomenologischen Reduktion (Erste Philosophie, 1923-24 (Edmund Husserl), Teil 2), herausgegeben von Rudolf Boehm (Husserliana, Band 8), *review* by F I G Rawlins, 1751
Theories A Re-examination of (Replication of Tobacco Mosaic Virus), (Prof Barry Commoner), 1998
Theory Axiomatic Set (Prof Paul Bernays), *review* by Dr L S Goddard, 1178
Theory of the Abrasion of Solids such as Metals (J Goddard, H J Harker and H Wilman), 333
Theory of Ageing (J Maynard Smith), 956 ; (Prof Leo Szilard), 957
Theory of Beams (T Iwinski), translated from the Polish by E P Bernat, *review* by T M Charlton, 1976
Theory of Integration An Introduction to the (Prof Adriaan C Zaanen), *review*, 574
Theory of the Ionosphere Recent Trends in the (J A Ratcliffe), 419
Theory (Analytic), of Numbers Some Recent Progress in the (Prof H Davenport), 1533
Theory (Clonal Selection), of Acquired Immunity (Sir Macfarlane Burnet), *review* by Dr J H Humphrey, 753
Theory (Copper Chelating), of their Mode of Action Plant-Growth Substances and the (Dr C H Fawcett), 796
Theory (Mathematical), of Compressible Fluid Flow (Richard von Mises), (completed by Hilda Geiringer and G S S Ludford), *review* by Dr W P Jones, 485
Theory (Modern), of the Integral, *review*, 574
Theory (Modern Network), in Electrical Engineering (University of Birmingham Conference on), 1691
Theory (Physical), of Neutron Chain Reactors (Alvin M Weinberg and Eugene P Wigner), *review* by Dr J Walker, 1973
Theory (Set) Foundations of (Prof Abraham A Fraenkel and Prof Yehoshua Bar-Hillel), *review* by Dr L S Goddard, 1178
Theory and Practice Electrophoresis in, *review* by Dr R Consden, 84
Theory and Practice of Semiconductors An Introduction to the (Dr A A Shepherd), *review* by Dr R A Hyman, 1754
Therapy (Bone Marrow) Interstrain Ovarian Transplantation in Lethally Irradiated Mice after (Prof W St Amand and L H Smith), 1503
Thermal Conductivity of Binary Gas Mixtures Sensitivity of Catharometers in Gas Chromatography and the (A B Littlewood), 1631
Thermal Decarboxylation of some Keto-Acid Hydrazones (Ambrose M Tokushige and Prof Elton S Cook), 267
Thermal Decomposition of Irradiated Lead Oxalate (P J Herley and E G Prout), 445
Thermal Equilibrium Influence of the Thomson Effect on the θ-φ Relationship for a Constrictive Resistance in (Dr W Davies), 975
Thermal Precipitator (Long-Running) Measurement of Asbestos Dust Concentrations with the (Dr C C Addingley and Dr R Gaze), 715
Thermal Reactor British Neutron Source, 1533
'Thermal Regeneration' in the Nickel–Oxygen System (Prof J S Anderson and D F Klemperer), 899
Thermochemistry Metallurgical (Dr O Kubaschewski and E Ll Evans), *review* by Dr F C Thompson, 1765
Thermodynamic Properties of Organic Compounds Some Remarks on the (Prof George S Parks), 1194
Thermodynamic Tables Polynomial Representation of (Prof C J Pings), 444
Thermodynamics (Deutsche Bunsengesellschaft fur Physikalische Chemie and the International Union of Pure and Applied Chemistry Symposium on), 1606
Developments in (Dr H A Skinner, K Schäfer and Dr J S Rowlinson), 1606
Thermo-Nuclear Physics at Sydney, 1447
Thermonuclear Processes (Institution of Electrical Engineers and the British Nuclear Energy Conference Convention on), 240
Thermonuclear Research (Physical Society Conference on), 1015
Thermoregulatory Heat Production in the Brain (Prof Sz Donhoffer, Gy Szegvari, I Jarai and M Farkas), 993
Thermo-Remanent Magnetism (Reverse) Exchange Interaction as a Cause of (T Nagata and S Uyeda), 890
Theron Mountains and Whichaway Nunataks, Antarctica Palaeomagnetism of some Dolerite Intrusions from the (D J Blundell and P J Stephenson), 1860
Thew, M T Appointed Volkes Research Fellow in mechanical engineering in the University of Southampton, 1915
Thiadiazoles (2-Substituted) Reversal of Effects of, by Nicotinamide Analogues and Precursors (Dr Irwin H Krakoff, Corrine R Lacon and Dr David A Karnofsky), 1805
Thiamine-sparing Action of Sorbitol in Rats and Mice (Dr T B Morgan and Prof John Yudkin), 909
Thibault, Dr Pierre, and others Statement on Biological and Chemical Warfare, 1018
Thickness of the Helium Film Measurement of the (Prof L C Jackson), 954
Thickness Measurement (Film), by Beam Interferometry Substrate Damage in (Prof G David Scott), 354
Thiessen, Clara P (Bentley, Prof Ronald, and) Tropolone Biosynthesis—the Enzymatic Decarboxylation of Stipitatonic and Puberulonic Acids, 552
Thilo, E Macromolecules (Inorganic and Organic/Inorganic Polymers), 1690
Thimann, Prof K V Plant Growth Regulation (Relation between Structure and Auxin Activity) 600
Things Are The Way (Prof P W Bridgman), *review* by Prof C K Grant, 1975
Thioctic Acid Effect of, on Gain in Body-Weight by Turkey Poults (J R Jowsey, R M Blakeley and H I MacGregor), 1323
Thioctic Acid (Intracellular), and Coenzyme A following Vanadium Treatment (E Mascitelli-Coriandoli and Dr C Citterio), 1641
Thiol Groups and Morphogenesis (Prof J Brachet), 1074
Thiols *in vitro* Metabolic and Chemical Studies of 'Myleran'—Formation of 3-Hydroxytetrahydrothiophene-1,1-dioxide *in vivo*, and Reactions with (Dr J J Roberts and Dr G P Warwick), 1288
Thionine in Rigid Medium Photolysis of—Measurement by Spectrofluorimetry (Dr C A Parker and W T Rees), 1223
Thiosulphate Metabolism in the Animal Organism (Prof Boleslaw Skarzynski, Tadeusz W Szczepkowski and Miroslawa Weber), 994
Thiotaurine Degradation of, by Ionizing Radiations (D Cavallini, B Mondovi, B Giovanella and C De Marco), B A 61
Thiouracil and Thyroxine Effect of, on Development and Growth of Cutaneous Melanoma in Killifish Hybrids (Prof A Stolk), 562
Thiourea and Insect Polyphenoloxidase Interaction between (Wanda Chmurzynska and Lech Wojtczak), 1941
Third Sex-linked Allelomorph of Silver and Gold in the Fowl Semi-Albino, a (W F Werret, A J Candy, J O L King and Dr P M Sheppard), 480
Thirst for Bile in Rats with Bile Fistulae (Dr Albert J Bertinchamps, James J Greenough and George C Cotzias), 1405
Thirtle, John R , and others (C F H Allen, in collaboration with) Six-Membered Heterocyclic Nitrogen Compounds with Three Condensed Rings, *review* by Dr F G Mann, 216
Thirumalachar, Dr M J (Desai, Dr V M , and) Floral Malformation in *Panicum antidotale* caused by a Species of *Eriophyses* 1586
Thoday, Prof J M Genetics and the Origin of Species, 588
Appointed to the Arthur Balfour chair of genetics in the University of Cambridge, 1189 , work of, 1189
Thoday, Prof J M (Gibson, J B , and) Recombinational Lethals in a Polymorphic Population 1593
Thomas, Dr A F Appointed lecturer in the Department of Organic Chemistry in the University of Leeds, 1534
Thomas, D W Appointed National Coal Board Research Fellow in physical chemistry in the University of Birmingham, 1915
Thomas, Glenys Appointed map curator and cartographer in the Department of Geography in the University College of Swansea, 156
Thomas, Dr G M Photography in the International Geophysical Year (Study of Aurorae by All-Sky Cameras), 1032
Thomas, Prof G W Salt Desorption from Halloysite, 1746
Thomas, Dr H A The Chemistry of Clothing (Recent Advances in the Application of Cellulosic Man-made Fibres to Clothing), 849
Thomas, Prof Henry C (Meites, Prof Louis, and) Advanced Analytical Chemistry, *review* by W I Stephen, 1525
Thomas, Dr J O , and Vickers, M D Conversion of Ionospheric Virtual Height-Frequency Curves to Electron Density-Height Profiles (Radio Research Board, Special Report No 28), 1024
Thomas, Dr J O , and others Two Anomalies in the Behaviour of the F2 Layer of the Ionosphere, 2003
Thomason, D , and Schofield, R Heparin and Cellular Calcium, 1712
Thome, P Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Welding by Electron Bombardment Heating), 693
Thompson, A B The Chemistry of Clothing (The Use of Synthetic Hydrophobic Fibres in Clothing), 850
Thompson, C F (Neely, W Brock, and) Kinetic Study of Dextransucrase based on the Langmuir Adsorption Isotherm, B A 64
Thompson, D C , and Macdonald, W J P Radiation Balance at Scott Base, 541
Thompson, Dr E O P Structure and Chemistry of Proteins—Symposium on Proteins at Parkville, Australia, 1276
Thompson, Dr E O P , and others Structure and Chemistry of Proteins (Methods of Splitting Disulphide Bonds and their Application in the Extraction of Soluble Proteins from Wool), 1277
Thompson, Prof F C Advancements in Metallurgy, *review*, 1765
A History of Iron and Steel in China, *review*, 1830
Thompson, H V At the Conference of the Mammal Society of the British Isles (Erosion caused by the Rabbit in Australia and New Zealand), 30
Thompson, H V , and others Myxomatosis—Present Position and Future Prospects in Great Britain 1179
Thompson, Dr N Atomic Mechanisms of Fracture, 325
Thompson, P A , and Guttridge, C G Effect of Gibberellic Acid on the Initiation of Flowers and Runners in the Strawberry, B A 72
Thompson, R E M Appointed reader in bacteriology at Middlesex Hospital Medical School, London, 322
Thompson, R J Chemistry of Propellants (Theoretical Performance Evaluation), 778
Thompson, R T The Weevils of France, *review*, 573
Thompson, Dr T E Development of the Aplacophorous Mollusc *Neomenia carinata* Tullberg, 122
Defensive Acid-Secretion in some Marine Gastropods, 1162
Thompson, Dr W B Promoted to Deputy Chief Scientific Officer in the Scientific Civil Service, 859 , work of, 859
Thermonuclear Research, 1017
Ionization Phenomena in Gases (Fine-scale Magneto-hydrodynamic Behaviour in Plasmas) 1356
Thompson (Boyce) Institute for Plant Research, and others Fourth International Conference on Plant Growth Regulation, 599
Thomson, Dr Andrew Retirement as director of the Meteorological Branch of the Canadian Department of Transport, 1105 , work of, 1105
Thomson, Dr A P D Appointed acting director of the Department of Anatomy in the University of Birmingham, 1915

Thomson, Sir George Elected president for 1960 of the British Association for the Advancement of Science, 151 , work of, 151
  Thermonuclear Processes, 241
  Elected president of the Institute of Physics, 604
Thomson, G G , and others Growth Responses to Selenium in Lambs, 251
Thomson, Dr J , and Callick, E B Electron Physics and Technology, *review* by Dr D A Bell, 83
Thomson, Sir Landsborough The Birds of the Palearctic Fauna, *review*, 666
  Birds of Prey, *review*, 1435
Thomson, R A M , and others A Modified Rotating-Sector Method of Measuring Kinetic Chain Lifetimes, 266
Thomson Effect Influence of the, on the θ-φ Relationship for a Constrictive Resistance in Thermal Equilibrium (Dr W Davies), 975
Thontadarya, T S , and Basavanna, G P Channa Mode of Egg Laying in Tingidae (Hemiptera), 289
Thorell, Dr Bo, and Chance, Prof Britton Localization and Assay of Respiratory Enzymes in Single Living Cells—Absorbancy Measurements on Liver and Kidney Cells, 934
Thorell, Dr Bo (Chance, Prof Britton, and) Localization and Assay of Respiratory Enzymes in Single Living Cells—Fluorescence Measurements of Mitochondrial Pyridine Nucleotide in Aerobiosis and Anaerobiosis, 931
Thorell, Dr Bo, and others Localization and Assay of Respiratory Enzymes in Single Living Cells—Absorbancy Measurements on the *Neberkern*, 929
Thorium Systematic Mineralogy of Uranium and (Prof Clifford Frondel), *review* by Prof C F Davidson, 576
Thorium Alloys (Uranium and) Constitutional Diagrams of (Frank A Rough and Arthur A Bauer), *review* by Dr R E D Hughes, 925
Thorndike, Prof Lynn A History of Magic and Experimental Science, Vols 7 and 8, The Seventeenth Century, *review* by Dr V A Eyles, 1899
Thornton, Charles S (edited by) Regeneration in Vertebrates (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Thornton, Dr J D (Ramshaw, Dr C , and) Droplet Circulation and Interfacial Disturbances in Gas–Liquid Systems, 719
Thornton, R H , and Sinclair, D P *Sporidesmium bakeri* and Facial Eczema of Sheep in the Field, 1327
Thorpe, Dr W H Knowing and Being, 1194
  Evolution of Behaviour, *review*, 1762
Thorpe, Dr W V Appointed chairman of the Editorial Board of the *Biochemical Journal*, 508
Thought (Western) The History of, *review* by Gerd Buchdahl, 1829
Threats to Broadcasting Two—Political and Commercial Control (H Carleton Greene), 661
Threlfall, C J Synthesis of Diphosphopyridine Nucleotide from Nicotinamide by Slices of Liver, 60
Thresher, Dr J J Nuclear Forces and the Few-Nucleon Problem (The Primary Two-Nucleon Interaction), 1113
Threshold of Space—the Proceedings of the Conference on Chemical Aeronomy, sponsored by the Geophysics Research Directorate, Air Force Cambridge Research Center, Cambridge, Mass , 1956 (edited by M Zelikoff), *review*, 1011
Thrombins Rivanol, Resin and the Isolation of (Dr Kent D Miller), 450
Thrombocytes (Human) Extraction of an Actomyosin-like Protein from (M Bettex-Galland and Dr E F Luscher), 276
Thromexane (the Anti-coagulant Drug Pelentane or) Isomeric O-Methyl Ethers of Ethyl di-(4-hydroxycoumarinyl-3)-Acetate (Dr Eduard Knobloch), 1568
Thurlow, S J (Moreland, Dr J D , and) Biomechanics (Problems connected with Road Crash Injuries), 513
Thurstone, Prof L L The Measurement of Values, *review* by Prof Ll Wynn Jones, 1010
Thwaites, Dr B Appointed to a third chair of mathematics, with special reference to fluid mechanics, in the University of Southampton, 590 , work of, 590
Thymectomized Mice Inoculated with Leukaemic Filtrate Fate of Subcutaneous Thymus Grafts in (J F A P Miller), 1809
Thymine Hydroperoxide produced by X-Irradiation Structure of (B Ekert and R Monier), B A 58
Thymus Influence of the, upon the Egg-White Allergy in the Rat (Dr J Comsa), 1726
Thymus in the Rat Effect of Adrenalectomy on the Hormone Content of the (Dr J Comsa), 279
Thymus (Calf) High Molecular Weight Ribonucleic Acids from the Nuclei of (Dr Ping-yao Cheng), 190
Thymus Grafts (Subcutaneous), in Thymectomized Mice Inoculated with Leukaemic Filtrate Fate of (J F A P Miller), 1809
Thymus Nuclei (Isolated) Monovalent Cations and the Incorporation of Metabolites by (Dr Theodore R Breitman and Dr George C Webster), 637
Thyroid Administration (Prolonged) Effect of, on Male Aged Rats (Prof John F Lhotka Lloyd Glenn McArthur and Arthur A Hellbaum) 1149
Thyroid Antibodies Detection of, using Bentonite Particles (Dr J A M Ager, Dr M S R Hutt and G Smith) 478
Thyroid Glands Accumulation of Radioactive Iodine in, subsequent to Nuclear Weapon Tests and the Accident at Windscale (Dr Hamish A Robertson and Ian R Falconer), 1699
Thyroid-stimulating Hormone (Fluorescent), in Rat Tissues Histological Localization of (Dr E E Mancini, O Vilar, J M Dellacha, A Gimeno and A Castro) 1733
Thyroidectomy Effects of Methylthiouracil or, on Activation of Pituitary Acid Phosphatases *in vitro* by Whole Hypothalamic Extract (Dr V Schreiber and Dr V Kmentova), 728
Thyroxine Effect of Thiouracil and, on Development and Growth of Cutaneous Melanoma in Killifish Hybrids (Prof A Stolk), 562
  Reversal by Acetylcholine of the Inhibition by of Oxidative Phosphorylation in Guinea Pig Heart Sarcosomes (Heitor Medina and Metry Bacila), 1066
Thys, O and others Production of an Agglutinating Auto-Antibody (Panagglutinin) Active upon Tanned Erythrocytes in the Rabbit, 1250
Thysanoessa raschii Spectral Composition of the Luminescence of the Euphausiid (Dr Brian P Boden and Dr Elizabeth M Kampa), 1321
Tick (Blue) Pyrethrum Resistance conferred by Resistance to DDT in the (G B Whitehead), 378
Tick (Blue), *Boophilus decoloratus* Contents of Cystine-Cysteine, Glutathione and Total Free Sulphydryl in Arsenic-resistant and Sensitive Strains of the (Dr J S Harington), 1739
Tick (Brown Ear), *Rhipicephalus appendiculatus* Neumann New Cell Types in the Salivary Glands of the (Dr W M Till), 1078
Tick-borne Encephalitis Virus Infectious Ribonucleic Acid from Mouse Brains infected with (F Sokol, H Libikova and J Zemla), 1581
Tide (Ebb and Flood) Discrimination between in Migrating Elvers (*Anguilla vulgaris* Turt) by means of Olfactory Perception (F Creutzberg), 1961
Tides in the F_2 Ionospheric Layer (Dr P Herrinck), 1055
Tiere Die Banderschnecken, eine Studie zur Evolution der (Prof Dr F A Schilder und Dr Maria Schilder), *review* by Dr A J Cain, 390
Tiffin, A I , and others Interaction of Sucrose Stearate with Starch, 110
  Interaction of Anti-Staling Agents with Starch, 547
Tilak, B D , and others Inhibition of Tumour Growth with 2 5-Dicarbethoxy-3 4-Dihydroxy-Thiophene, 201
Tilapia nigra Feeding Mechanism of (Peter J Whitehead), 1509
Tilapia nilotica x *T galilea* Hybrids of (A Yashouv and J Chervinsky), 1739
Till, Dr W M New Cell Types in the Salivary Glands of the Brown Ear Tick, *Rhipicephalus appendiculatus* Neumann, 1078
Tilley, Dr J M A Strontium-90 in Human Diet, 1111
Tillman, Dr J R Advances in Electronics and Electron Physics, *review*, 1601
  Rochester Conference on Semiconductors, *review*, 1674
Tillotson, E Yellowstone Park Earthquake, 955
Timber Limitations Imposed by some Water-borne Preservatives on the Soil Block Test Method for (A J McQuire), 1430
Time An Absolute Scale of (Sir John Carroll), 260
Time Ball at Greenwich, 318
Time Effects (Polarization and Resolving), in Photon Correlations (Dr E Brannen and Prof W Wehlau), 263
Time Relations of Humorally Co-ordinated Chromatic Responses Significance of the (Dr A K Kent), 2027
Time-Scale The Geological (Prof J Laurence Kulp, James C Cobb, Leon E Long and Donald S Miller), B A 62 , (Prof C F Davidson), 1310, 1473
Time Standard An Improved Caesium Frequency and (Dr L Essen and J V L Parry), 1791
Times (The Life and), of Sir Charles Hastings Founder of the British Medical Association (Dr William H McMenemey), *review* by Dr W R Bett, 923
Times (Renewal), of some Squamous Epithelia in the Guinea Pig (H Platt), 1654
Timmis, G M , and Epstein, Dr S S New Antimetabolites from Vitamin B_{12}, 1383
Timon, Vivian Awarded a junior postgraduate agricultural research scholarship by An Foras Taluntais (the Agricultural Institute of Ireland), 1612
Tineola bisselliella (Humm) A Reduced Triphosphopyridine Nucleotide-linked Cystine Reductase in the Clothes Moth (R F Powning and H Irzykiewicz), 1230
Tinfoil to Tape From—the History of the Gramophone (John Cain), 1535
Tingidae (Hemiptera) Mode of Egg Laying in (T S Thontadarya and G P Channa Basavanna), 289
Tingwaldt, C Thermodynamics (Physical Constants), 1608
Tipper, Dr D J , and others Some Observations on certain Mucoproteins containing Neuraminic Acid B A 68
  N-Methylation of Methyl 2-Acetamido-2-Deoxy-α-D-Glucopyranoside, 1718
Tipson, R Stuart (edited by Melville L Wolfrom in association with) Advances in Carbohydrate Chemistry, Vol 13, *review* by Dr Alfred Gottschalk, 662
Tissue Low-Temperature Autoradiography for the Detection of Tritium in, with Removal of Luminescence induced by Tritium (P Pellerin, P Fallor, M Laine-Boszormenyi and F Serrel), 1385
Tissue (Adipose) in Normal and Diabetic Rats Release of Non-Esterified Fatty Acids from (Dr J Wendeova and Dr J Pav), 1147
Tissue (Apple) Oxidation of Krebs Cycle Acids by (M D Hatch, J A Pearson, A Millerd and R N Robertson), 506
Tissue (Brain) Presence of certain Onium Compounds in, following Intravenous Administration to Rats (Prof Ruth R Levine), 1412
Tissue (Brown and Yellow Adipose), of the Bat Lipase Activity in the (Prof J C George and J Eapen), 59
Tissue (Chick Mesenchymal) Production of Serum Albumin and of Globulins by, and by HeLa Tumour Tissue in Culture (Y Abdel-Samie, Prof E Broda, G Kellner and W Zischka), 361, *erratum*, 943
Tissue (Connective) Diaphragms for Analysing the Development of (Prof Hans Selye), 701
Tissue (HeLa Tumour) Production of Serum Albumin and of Globulins by Chick Mesenchymal Tissue and by, in Culture (Y Abdel-Samie, Prof E Broda, G Kellner and W Zischka), 361, *erratum*, 943
Tissue (Lymphomatous Mouse) Partial Identification of Lysins and Agglutinins in (Dr Eric Ponder and Ruth V Ponder) 819
Tissue (Rat Oral) Effect of Vitamin D on the Respiration of (L Zar and Prof J T Irving), 1410
Tissue Culture An Attenuated Strain of Canine Distemper Virus in (Prof Gunnar Rockborn), 822
  Cell and (Dr John Paul), *review* by Dr I Leslie, 1009
  Transformations of Myxoma into Vaccinia or Ectromelia Virus in (Hidesaburô Hanafusa, Teruko Hanafusa and Juntarô Kamahora), 1152
Tissue Culture (Tsetse Fly) Development of *Trypanosoma vivax* to the Infective Stage in (Dr William Trager), B A 30
Tissue Culture Cells (Human) Cellular Uptake of Deoxyribonucleic Acid by (Dr Stanley M Gartler), 1505
Tissue Culture Monolayers (Pig Kidney) Effect of Proflavine on the Formation of the Virus of Foot-and-Mouth Disease and its Infective Ribonucleic Acid in (F Brown and Doreen L Stewart), B A 74
Tissue Cultures (Plant) Oxidative and Phosphorylative Activities of Cytoplasmic Particles from (Taiki Tamaoki, Prof A C Hildebrandt, A J Riker, R H Burris and Bunji Hagihara), 1491
Tissue Cultures (Roller Tube) Use of Transparent Cellular Film for (John A Sharp), 1508

Tissue Extracts (Animal) Occurrence and Quantitative Determination of 2-Dimethylaminoethanol in (Dr Conrad G Honegger and Ruth Honegger), 550, *erratum*, 1986
Tissue Extracts (Tomato Crown-Gall) Occurrence of 3-Indolylacetic and 3-Indolecarboxylic Acids in (G Clarke, M H Dye and Prof R L Wain), 825
Tissue Fragments (Parathyroid) Maintenance of, on Agar Substrates (Dr John H Wallace, Dr George J Hill, Jean M McCarthy and Dr John R Brooks), 1734
Tissue Mucoproteins Determination of (Luiz A Abreu and R Raposo Abreu), 2016
Tissue Repair Wound Healing and (edited by W Bradford Patterson), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Tissue Slices Application of Warburg's Equation to (Dr I S Longmuir and Dr Ann Bourke), 634
Tissues Mast Cell Population of Lung of the Guinea Pig and other (Dr W G Smith), 1154
Tissues Deficient in Vitamin E An Effect of Selenium and Cystine on Lipide Peroxidation in (Dr John G Bieri), 1148
Tissues of the Foetal and Adult Sheep Inositol Concentration in the Cerebrospinal and Ocular Fluids and (D A Nixon), 906
Tissues (Adult Lymphoid) Influence of, on Polyoma-induced Tumours (Dr V Defendi and Dr H Koprowski), 1579
Tissues (Cultured Human) Sex Chromatin in (Dr Charles P Miles), 477
Tissues (Different), and Subcellular Fractions Distribution of Enzyme Systems responsible for Steroid Metabolism in (Virendra B Mahesh and Frank Ulrich), 1147
Tissues (Eye) Distribution of Radioactive Barium in (R J Garner), 733
Tissues (Liver, Kidney and adjacent) Tumourigenesis in Ovaries of Mice transplanted to the (Dr Mary J Guthrie), 916
Tissues (Mouse) Ribonucleases of, and of the Ehrlich Ascites Tumour (K A O Ellem, J S Colter and Jeanne Kuhn), 984
Tissues (Muscle) Determination of Chlorine in, by Neutron Activation Analysis (Dr Jonas Bergstrom), 1504
Tissues (Plant) Biochemical Mechanism of Lesion Formation in Virus-infected (Dr F Solymosy, Dr G L Farkas and Dr Z Kiraly), 706
Tissues (Proliferating) Dynamics of (edited by Dorothy Price), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council) *review* by Dr D R Newth, 839
Tissues (Rat) Histological Localization of Fluorescent Thyroid-stimulating Hormone in (Dr E E Mancini, O Vilar, J M Dellacha, A Gimeno and A Castro), 1733
Tissues (Rinderpest-infected Bovine) Heat Inactivation of (Dr G R Scott), 1948
Titanium as a Gettering Material (R L Scow), 542
Titanium Dioxide Pigment Particles Forces between (James E Latty and Dr W C Clark), 49
Titchen, Dr D A (Sellers, Prof A F, and) Responses to Localized Distension of the Oesophagus in Decerebrate Sheep, 645
Titration (Sub-Micro), of Derivatives containing Nitro Groups Quantitative Paper Chromatography based on the (L Blom and J Caris), 1313
Titration Curves of Soil Organic Matter (R S Beckwith), 745
Titrimetric Analysis Nomenclature in (Committee of the Analytical Chemistry Section of the International Union of Pure and Applied Chemistry), 1686
Titschack, Prof Dr Erich, und Koepcke, Dr Hans-Wilhelm (herausgegeben von) Beitrage zur Neotropischen Fauna, Band I, Heft 3, Zur Kenntnis der Pseudoscorpioniden-Fauna des Andengebietes (Max Beier), Kritische Untersuchungen der Newportia-Arten (Wolfgand Bucherl), Ein neuer *Asthenes* (Aves, Furnariidae) von der Kuste und dem westlichen Andenabhang Sudperus (Maria Koepcke), Beitrage zur Kenntnis der Fische Perus, II (Hans-Wilhelm Koepcke), *review* by Dr F A Turk, 1177
Titterton, Prof E W, and others Strontium-90 in the Australian Environment, 1957-58, 755
Tjebbes, J Thermodynamics (Experimental Thermochemistry), 1607
Tobacco (Maryland Mammoth) Isolation of Fatty Alcohols with Plant-Growth Promoting Activity from (Dr A J Vlitos and Dr D G Crosby), 462
Tobacco Hornworm, *Protoparce sexta* (Johan) and the Colorado Potato Beetle, *Leptinotarsa decemlineata* (Say) Common Attractant for the (Dr Robert T Yamamoto and Prof G Fraenkel), 206
Tobacco Leaf and Tobacco Smoke Composition of a Paraffin Wax Fraction from (Dr W Carruthers and Dr R A W Johnstone), 1131
Tobacco Leaf Cells capable of Supporting Virus Multiplication Isolation of (Prof Milton Zaitlin), 1002
Tobacco Mosaic Virus Effect of Nitrous Acid on—Mutation or Selection? (F C Bawden), B A 27
  Replication of—Kinetics of Virus Protein and Ribonucleic Acid Biosynthesis (Prof Barry Commoner, Dr James A Lippincott and Dr Janey Symington), 1992, A Re-examination of Theories (Prof Barry Commoner), 1998
  Rotational Friction Coefficients of Models of and the Size of the Virus Particle (Dr A J Haltner and Dr B H Zimm), 265
Tobacco Mosaic Virus inactivated by Antibody Recovery of Infectious Nucleic Acid from (Dr Irving Rappaport), 1732
Tobacco Smoke (Tobacco Leaf and) Composition of a Paraffin Wax Fraction from (Dr W Carruthers and Dr R A W Johnstone), 1131
Tobias, Cornelius A, and Lawrence, John H (edited by) Advances in Biological and Medical Physics, Vol 6, *review* by Dr N M Blackett, 1766
Tobias, Stanley, and others Tumour Specificity and Immunological Suppression, 563
Tobias, Dr S A Appointed to the Chance chair of mechanical engineering in the University of Birmingham, 502, work of, 502
Tocopherols in Micro-organisms (J Green, S A Price and L Gare), 1339
Todorov, Y, and others Agar Electrophoresis of Normal Soluble Proteins in Guinea Pig Liver, B A 64
Tokushige, Ambrose M, and Cook, Prof Elton S Thermal Decarboxylation of some Keto-Acid Hydrazones, 267
Tolansky, Prof S, and Sunigawa, Dr I Spiral and other Growth Forms of Synthetic Diamonds—a Distinction between Natural and Synthetic Diamond, 1526
Tolerance to Skin Homografts of Adult Mice after Parabiosis (Dr B A Rubin), 205
Tolerance (Ethanol), of Rats Sex Difference in (Henrik Wallgren), 726
Tolerance (Heat), Exhibited by *Bos taurus* and *Bos indicus* Beef Cattle A Possible Explanation for Part of the Difference in (H P Ledger), 1405
Tolerance (Induced), to D-Tubocurarine Chloride in the Cat (Fiona Acheson and Dr R J M Fry) 1409
Tolley, Dr G Personnel Management and Technological Change (Progress of Technological Education in the United States, the U S S R and Great Britain), 1614
Tolmatchev, A Origin and Dispersal of Flowering Plants (Arctic Flora first formed in the Pliocene–Pleistocene), 1200
Toluidines Separation of the *Meta-* and *Para-*Isomers of the Xylenes Cresols and, by Gas Solid Chromatography (M A Hughes, D White and Prof A L Roberts), 1796
Tomaschek, Prof R Great Earthquakes and the Astronomical Positions of Uranus, 177
Tomato Crown-Gall Tissue Extracts Occurrence of 3-Indolylacetic and 3-Indolecarboxylic Acids in (G Clarke, M H Dye and Prof R L Wain), 825
Tomato Roots (Excised) Nitrate Reduction by Aqueous Extracts of (C S. Vaidyanathan and Prof H E Street), 531
  A Non-Dialysable Inhibitor of Glutamo-Transferase present in (C S Vaidyanathan and Prof H E Street), 347
Tomato and Banana Strains of *Pseudomonas solanacearum* Comparison of Slime from (Dr W F Dudman), 1969
Tomatoes Production of Ethylene by Mitochondria from (Prof Mary S Spencer), 1231
Tomchick, Dr Robert (Axelrod, Dr Julius, and) Activation and Inhibition of Adrenaline Metabolism, 2027
Tomich, E G, and others Spectrophotofluorometric Assay of Griseofulvin, 364
Tomkeieff, Prof S I The Periodic Law, *review*, 1598
  Metallogenic Maps, 1693
Tomlinson, T E (Homer, R F, and) Redox Properties of some Dipyridyl Quaternary Salts, 2012
Tompkins, Dr F C Title of professor of physical chemistry in the University of London (at the Imperial College of Science and Technology) conferred on, 1273
Tong, E H Looking for Animals in East Africa (Christmas Lecture at the Zoological Society of London), 1535
Tonic Smooth Muscles of Lamellibranch Molluscs Evidence for a Sliding Filament Contractile Mechanism in (Dr Jean Hanson and Dr J Lowy), 286
Tool in Clinical Metabolic Research Enzymic Activities of Human Skeletal Muscle Mitochondria—a (Dr L Ernster, Dr D Ikkos and Dr R Luft), 1851
Tool for Industry Radiation, a (National Industrial Conference Board, Inc seventh Annual Conference on Atomic Energy in Industry), 506
Toovey, F W Glasshouse Crops Research Institute—Open Day, 1033
Top Growth of Cultivated Tea (Dr D N Barua), 1424
Topchiev, A V Nitration of Hydrocarbons and other Organic Compounds (translated from the Russian by Catherine Matthews), *review* by Prof M J S Dewar, 577
Topography (Surface), of the Antarctic Ice Sheet (Dr J F Nye), 786
Toriyama, Hideo Changes in the Lacunal Parenchyma of *Mimosa pudica* in Diurnal and Nocturnal Conditions, 737
Torkelson, T R, and others Post-Exposure Analysis of Organic Compounds in the Blood by a Rapid Infra-red Technique, 192
Torry Research Station, Aberdeen Open Days (Dr G H O Burgess), 863
Torulopsis utilis Glycolaldehyde Trapped from Aerobic Oxidation of D-Xylose by (V Bolcato and G Leggiero), 1318
Total Free Sulphydryl (Cystine-Cysteine, Glutathione and) Contents of, in Arsenic-resistant and Sensitive Strains of the Blue Tick, *Boophilus decoloratus* (Dr J S Harington), 1739
Total Mammary Glands of the Mouse Organ Cultures of (Dr F J A Prop), 379
Total Protein from Wheaten Flour Extraction of the, in the Form of Soluble Derivatives (E E McDermott and Dr J Pace), 546
Tousey, Dr R, and others Lyman-Alpha Photographs of the Sun, 8
Touster, Prof Oscar (Bozian, Dr R C, and) Essential Pentosuria—Renal or Enzymic Disorder, 463
Tove, Prof S B Production of Odd-Numbered Carbon Fatty Acids from Propionate by Mice, 1647
Toward a Systematic Pragmatics (R M Martin), *review* by F I G Rawlins, 754
Townes, Prof C H (Cedarholm, J P, and) A New Experimental Test of Special Relativity, 1350
Towers, Prof G H N (Ibrahim, Dr Ragai K, and) Conversion of Salicylic Acid to Gentisic Acid and *o*-Pyrocatechuic Acid, all Labelled with Carbon-14, in Plants, 1803
Towns (Two) After Work—Leisure and Learning in (R Ruddock and Dr A Wilson), 1034
Townsley, J D, and others Effect of Steroids and related Compounds on the Growth of Dermatophytes, 1731
Toxaemia after Burning, *review* by Dr S Sevitt, 5
Toxicity of Cationic Macromolecules Reduction of, by Complexing with Anionic Derivatives of Synthetic Polyglucoses (P T Mora, B G Young and M J Shear), 431
Toxoid of Histamine Sensitizing Factor Formation of the, in *Bordetella pertussis* (Prof Toshitaka Matsui and Yoshio Kuwajima), 199
Toxoplasmosis Ovine Abortion due to (Dr J K A Beverley and W A Watson), 2041
Trace Elements in Basic Magma Deposition of (R J P Williams), 44
Trace Elements in Marine Biological Ashes Some Activation Analysis of Six (R Fukai and Prof W W Meinke), 815
Trace Metals in Cheese Fat Oxidation and (Tallowy Discoloration in Cheddar Cheese), (F Bishop), 1295
Tracer Applications for the Study of Organic Reactions (John G Burr, Jr), *review* by Dr A I Scott, 1902
Tracer Study (A Radiochemical), of the Relative Stability of the Halogenoplatinates (A J Poe and M S Vaidya), 1139
Trachysaurus rugosus (Gray) Effects of Elevated Plasma Sodium Concentration on Sodium and Potassium in the Erythrocyte of the Lizard (P J Bentley), 1403

Tracks (Low-Energy Particle) Bubble Counting on (I R Birss), 1474
Trackways (Prehistoric Wooden) Radiocarbon Dating of (Dr H Godwin and Dr E H Willis), 490
Trade (Free), in Land in the Victorian Period (O R McGregor), 1916
Trade Waste Treatment River Pollution Sewage Disposal and (Department of Civil Engineering and the Department of Extra-Mural Studies in the University of Birmingham Course on), 1451
Tradition (Scholarly) Nuclear Technology and the, *review* by Dr J Walker, 1973
Traffic Engineering (Highway and), at Birmingham, 939
Tragacanth (Powdered), Tragacanthae Pulvis B P Growth Inhibition of Mouse Ascites Tumour Cells by (Dr E M F Roe), 1891
Trager, Dr William Development of *Trypanosoma vivax* to the Infective Stage in Tsetse Fly Tissue Culture, B A 30
Train, Dr D Title of reader in pharmaceutics in the University of London (at the School of Pharmacy) conferred on, 1108
  Pharmaceutical Research in the U S S R , *review*, 1831
Training New Developments in—Five Studies in the Efficient Communication of Skills (edited by Frank A Heller), 421
Training (Post-Graduate), in the Public Health Aspects of Nuclear Energy (World Health Organization, Technical Report Series No 154), 33
Training Course (Regional), on Diagnosis, Improvement and Management of Salt-affected Soils (Unesco Middle East Science Co-operation Office), 1778
Training Course (Regional), for Laboratory Technicians (University Institute of Chemistry, Lahore), 857
Training Facilities in Britain Expansion of Educational and, 569
Training Scholarship (Research), of the Animal Health Trust awarded to W A G Charleston, 771
Tranquillizers (Phenothiazine-) Differential Analysis of the Effects of, on Emotional and Motor Behaviour in Experimental Animals (Dr M Taeschler and Dr A Cerletti) 823
Tranquillizing Drugs Effect of on Survival from Experimental Diphtheric Intoxication (Prof Leo Greenberg and Dr James W Ingalls), 1721
Transaminase (Glutamic-Pyruvic), in Rabbit's Long Bones (L Tessari and L Parrini), 904
Transaminases in *Shigellae* (Dr Ranjit Sen), 741
Transducers (Paste) Ultrasonic Barium Titanate Adhesion and (Dr A Lutsch), 1458
Transduction in *Pseudomonas aeruginosa* (Dr B W Holloway and Marilyn Monk), 1426
  Effect of Ultra-Violet Irradiation on (J S Loutit), 1960
Trans-Equatorial Migrant (the Short-tailed Shearwater *Puffinus tenuirostris*) Experimental Demonstration of an Internal Rhythm of Reproduction in a (Dr A J Marshall and Dr D L Serventy), 1704
Transfer (Energy), with special reference to Biological Systems (Faraday Society Discussion on), 688
Transfer (Interocular) Some New Subjective Phenomena apparently due to (Ian P Howard) 1516
Transfer Mechanisms of Electronic Excitation (Prof Th Forster), 688
Transferase (Glutamo-) A Non-Dialysable Inhibitor of, present in Excised Tomato Roots (C S Vaidyanathan and Prof H E Street), 347
Transferrin Variants Haptoglobin and, in Bushmen and some other South African Peoples (Dr N A Barnicot, J P Garlick, Ronald Singer and Dr J S Weiner), 2042
Transformation of Cubic Boron Nitride to a Graphitic Form of Hexagonal Boron Nitride (H Judith Milledge, E Nave and F H Weller), 715
Transformation (Microbiological), of a Cardiac Aglycone (Hayao Nawa, Masao Uchibayashi, Takaaki Kamiya, Togo Yamano, Hideo Arai and Matazo Abe), 469
Transformation Reaction of Pneumococci in the Absence of Serum Factor (Prof Takeshi Odaka and Tadashi Watanabe), 471
Transformations of Myxoma into Vaccinia or Ectromelia Virus in Tissue Culture (Hidesaburô Hanafusa, Teruko Hanafusa and Juntarô Kamahora), 1152
Transformations (Martensitic), in Metals and Alloys (Academician G V Kurdjumov), 1450
Transforming Principle of *Bacillus subtilis* Incorporation of 5-Bromouracil into, and its Biological Effects (Dr Erela Ephrati-Elizur and Prof Stephen Zamenhof), 472
Transistor Circuits Use of the Silicon Resistor in the d c Stabilization of (J T Zakrzewski and D H Mehrtens), 811
Transistor Convention and Exhibition (F F Roberts and H G Bassett), 693
Transistor Electronics, *review* by J W R Griffiths, 838
Transistor Electronics (Arthur W Lo, Richard O Endres, Jakob Zawels, Fred D Waldhauer and Chung-Chih Cheng), *review* by J W R Griffiths, 838
  Junction (Richard B Hurley), *review* by J W R Griffiths, 838
Transistor Exhibition International (Electronics and Communications Section of the Institution of Electrical Engineers), 693
Transistors and Associated Semiconductor Devices (Electronics and Communications Section of the Institution of Electrical Engineers International Conference on), 693
Transition of Calcium Sulphate Hemihydrate to Insoluble Anhydrite (Chikara Mitsuki and Masayoshi Kita), 1481
Transitions (Phase), in Interlamellar Films (Dr D M C MacEwan and Dr F Aragon de la Cruz), 1859
Translocation of Carbon-14-labelled Amino-Acids and Amides in the Stems of young Soya Bean Plants (C D Nelson and P R Gorham), 855
Translocation of Cobalt-60 and Caesium-137 by Fungi in Agar and Soil Cultures (Dr Erna Grossbard and Dr D R Stranks), 310
Transmission of Passive Immunity in an Insectivore (B Morris), 1151
Transmission of a Virus to Strawberry Plants by a Nematode (*Xiphinema* sp), (Asharfi Jha and Dr A F Posnette), 962, *erratum*, 1192
Transmission (Needle), of a New Maize Virus (Dr I Harpaz), B A 77
Transparent Cellulose Film Use of, for Roller Tube Tissue Cultures (John A Sharp), 1508
Transparent Sintered Alumina—'Lucalox' (General Electric Company of America), 1107
Transplantable Mouse Plasma-Cell Neoplasm Bence Jones Proteinuria associated with a (John L Fahey and Michael Potter), 654, *erratum* 1108
Transplantation (Interstrain Ovarian), in Lethally Irradiated Mice after Bone Marrow Therapy (Prof W St Amand and L H Smith), 1503
Transplantation Immunity—Separation of Antigenic Components from Isolated Nuclei (Andre Castermans and Andre Oth), 1224
Transplanted Tumours in the Mouse Effect of Bacillus Calmette-Guerin Infection on (Dr Lloyd J Old, Dr Donald Q Clarke and Dr Baruj Benacerraf), 291
Transport, Canadian Department of Retirement of Dr Andrew Thomson as director of the Meteorological Branch, 1105
  Appointment of Patrick D McTaggart-Cowan as director of the Meteorological Branch, 1105
Transport of Driftwood from South America to Tasmania and Macquarie Island (Prof H N Barber, Dr H E Dadswell and H D Ingle), 203
Transport of 3-Indole Acetic Acid in *Avena* Electrical Determination of (I A Newman), 1728
Transport and Communications The Critical Importance of (Sir Ewart Smith), B A 44
Transport (Active), of Uric Acid through the Human Erythrocyte Membrane (Dr Kay Overgaard-Hansen and Dr Ulrik V Lassen), 553
Transport (Hydrogen), of Phenolic Œstrogens Two Enzymic Mechanisms for (Dr H G Williams-Ashman, M Cassman and Margaret Klavins), 427
Transport (Monosaccharide), in Rat Diaphragm Muscle (F C Battaglia and P J Randle) 1713
Transportation (Weed) New Zealand Research on, 1361
Trans-Unsaturated Acids in the Depot Fats of Ruminants and Non-Ruminants (L Hartman and Dr F B Shorland), 2024
Transuranium Elements (Prof Glenn T Seaborg) *review* by Dr J K Dawson, 922
Travel Grants under the Fulbright Programme, 1273
Travelling Disturbances (Giant), and Sporadic *E* Ionization A Relation between (L H Heisler), 1788
Travelling Research Fellowships Carlsberg–Wellcome (Awards) 683
Trawl Fishery (Tropical) Prediction of Selection Factors in a (Alan R Longhurst), 1170
Treasury Control of Expenditure (Observations of the Treasury), (Seventh Special Report from the Select Committee on Estimates, Session 1958-59), 696
Treatment Nuclear Fuel, *review* by Dr J E Littlechild, 1346
Treatment by Arginase Inhibitor Uraemia and its (Dhruba K Sen), 459
Treatment of Kwashiorkor Changes in the Level of Serum Protein during (Dr Olumbe Bassir), 2019
Treatment (Heat) Electrical Resistivity Changes observed in a Semiconducting Diamond after (R E Mutch and Dr F A Raal) 1857
Treatment (Trade Waste) River Pollution Sewage Disposal and (Department of Civil Engineering and the Department of Extra-Mural Studies in the University of Birmingham Course on), 1451
Treatment (Vanadium) Intracellular Thioctic Acid and Coenzyme A following (E Mascitelli-Coriandoli and Dr C Citterio), 1641
Tree Fruit Production (Dr James S Shoemaker and Dr Benjamin J E Teskey), *review* by Prof H W Miles, 487
Tree (Forest-) Litter Extracts Factors in, affecting the Growth of Soil Micro Organisms (Dr Roger Knowles and Edward Laishley), 1169
Tregallas-Williams, Dr J At the Second Australian Spectroscopy Conference (A Fast-scanning Infra-red Spectrometer equipped with a Cooled Lead–Tellurium Detector), 1197
Treibs, Prof Wilhelm Elected a member of the Chemistry Section of the Leopoldina Academy of Natural Sciences, 595
Trends in Birth Rates in the United States since 1870 (Dr Bernard Okun), *review* 134
Trends in Genetic Analysis (Prof G Pontecorvo), *review* by J Maynard Smith, 752
Trends in Palaeontology Recent Developments and (Prof O M B Bulman), B A 42
Trends in Statistics Teaching, *review* by J Durbin, 1008
Trends in the Theory of the Ionosphere Recent (J A Ratcliffe), 419
Trends in Urban Expansion (Prof K C Edwards), B A 43
Trends (Current), of Strontium-90, Strontium-89 and Caesium-137 Levels in Milk (W Anderson, L K Burton and J O Crookall), 89
Trends (Development), in Australian Scientific Research, 1027
Trevelyan Scholarships Second awards of, 1845
Trew Microfilming, Ltd Microcard Adapter for 'Dagmar' Microfilm Reader, 941
Trials (Agricultural Variety) Influence of Site and Season on (A Sandison), 834
s-Triazines and Derivatives (edited by Edwin M Smolin and Lorence Rapoport), (Chemistry of Heterocyclic Compounds, Vol 13), *review* by Dr F G Mann, 1758
Trichostrongylus retortaeformis (Zeder, 1800) A Seasonal Sex Difference in the Infestation of Rabbits with the Nematode (P C Bull), 281
Trichosurus vulpecula (Brush-tailed Opossum), in New Zealand Bionomics of the (R I Kean), 1388
Trichothecin-like Antifungal Antibiotic A New (E T Glaz, Eszter Scheiber, J Gyimesi, I Horvath, Katalin Steczek, A Szentirmai and G Bohus), 908
Trifolium pratense L Floral Initiation and its Relationship to Growth-Stage in Red Clover (J L Stoddart), 559
Trifolium repens Separation by Gamma-Irradiation of Two Elements at the Vby Locus in (Dr D Roy Davies and E T Wall), 1957
Trigonometric Series (Prof A Zygmund), second edition, *review* by Prof T A A Broadbent, 1176
3,4,ω-Trihydroxyacetophenone 3-methyl Ether in Adrenal Extracts (J von Euw, Prof T Reichstein, R Neher, Dr A Wettstein, Dr J F Tait and Dr S A S Tait), 268
Triphosphate (Adenosine) Equilibrium Constant of the Galactokinase Reaction and Free Energy of Hydrolysis of (Dr M B Atkinson, Eleanor Johnson and Prof R K Morton), 1925
Triphosphate (Adenosine), and Serotonin Release of, from Injured Cellular Blood Elements in Extracorporeal Circuits (Dr H S S Sarajas, Dr R Kristoffersson and Dr M H Frick), 1127
Tri-phosphate (Adenosine Di- and) Concentrations Changes in, in the Early Stages of the Action of Yeast on Glucose (Dr J O Laws and Dr L H Stickland), 1246
Triphosphate (Cytidine) Positive Inotropic Activity of (Winifred G Nayler and Marian McCulloch), 67
Triphosphopyridine Nucleotide-linked Cystine Reductase A Reduced, in the Clothes Moth, *Tineola bisselliella* (Humm (R P Powning and H Irzykiewicz), 1230

Triple Fission of Uranium-235 , Two Cases of (J Catala J Casanova and V Domingo), 1057
Triterpenes and their Derivatives (The Terpenes, by the late Sir John Simonsen and Dr W J C Ross, Vol 5), *review* by Prof A J Birch, 302
Tritium Chromosomal Synthesis of Ribonucleic Acid as shown by Incorporation of Uridine labelled with (G Pelling), 655
  Fate of Injected Dextran Labelled with, in Mice (Å Hanngren, E Hansson, S Ullberg and Prof B Åberg), 373
  Low-Temperature Autoradiography for the Detection of Tritium in Tissue, with Removal of Luminescence induced by (P Pellerin, P Fallot, M Laine-Boszormenyi and F Serrel), 1385
  Use of, to Study the Solubility of Water in Hydrocarbons (B D Caddock and P L Davies), 2011
Tritium in Tissue Low-Temperature Autoradiography for the Detection of, with Removal of Luminescence induced by Tritium (P Pellerin, P Fallot, M Laine-Boszormenyi and F Serrel), 1385
Tritium Exchange *In vitro* Labelling of Antibody Globulin by (Dr P C Rajam and Anne-Louise Jackson), 375
Tritium-labelled Compounds Autoradiography of, on Paper Chromatograms (Dr A W Rogers), 721
Trivedi, T Pollen of *Acacia* from Tufaceous Limestone near Udaipur, 123
Tritton, D J Appointed Rutherford Scholar for 1959, 26
Tropical Africa The Insect Pests of Cotton in (E O Pearson, assisted by R C Maxwell Darling), *review* by Dr W E China, 1011
Tropical Breed of Hair Sheep Light Regulation of Coat-Shedding in a (R B Symington), 1076
Tropical Catchment Areas A Physical Basis for Land Use Policy in (Dr H C Pereira), 1768
Tropical East Africa Flora of—Leguminosae subfamily Mimosoideae (J P M Brenan), 409
Tropical Regions The Calculation of the Median Sky Wave Field Strength in (W R Piggott), 605
Tropical Trawl Fishery Prediction of Selection Factors in a (Alan R Longhurst), 1170
Tropics Radio Field-Strengths in the, 605
Tropolone Biosynthesis—the Enzymatic Decarboxylation of Stipitatonic and Puberulonic Acids (Prof Ronald Bentley and Clara P Thiessen), 552
Tropospheric Radio Propagation Inadequacy of Scatter Mechanisms in (P C M de Belatini), 1558
Tropylium Ion Isomerization to the, induced by Electron Impact and its Significance (Dr W Hanuš), 1796
Trotman-Dickenson, A F Free Radicals, an Introduction, *review* by Dr T M Sugden, 1259
Trotter, M D , and others Delayed Hypersensitivity ('Tuberculin-like' Reactions to Trichophytin in Guinea Pigs), 1030
Trounce, Dr J H Title of reader in therapeutics in the University of London (at Guy's Hospital Medical School) conferred on, 322
Trout (Rainbow) Changes in Purine Nucleotides of Red Lateral Muscle of (Tsuneyuki Saito, Ken-ichi Arai and Toshikatsu Yajima) 1415
Trowell, Dr O A Cell and Organ Culture (Principles and Practice of Organ Culture), 936
Tryhorn, Dr F G , and others Absorption of Zinc Phosphide Particles, 642
Trusts (Newspaper) The Work of (Political and Economic Planning, Broadsheet No 435), 1687
Trypanosoma vivax Development of, to the Infective Stage in Tsetse Fly Tissue Culture (Dr William Trager), B A 30
Trypanosomal Extracts Paper Electrophoresis of (Dr Robert S Desowitz), 986
Trypsin Action of, on α-Carbethoxy-L-lysyl-L-serylglycine and its O-Phosphorylated Analogue (Dr D Theodoropoulos H Bennich, G Folsch and Prof O Mellander), 187
  Electrophoretic Heterogeneity of (J C Perrone, L V Disitzer and A Iachan), 1225
Tryptic Action O-Phosphorylated and Unphosphorylated Peptide-Substrates suitable for (Dr D Theodoropoulos, H Bennich and Prof O Mellander), 270
Tryptophan-requiring Strain of *Escherichia coli* Effect of Purine and Pyrimidine Analogues on Reversion of a (C O Doudney and F L Haas), 114
Tryptophan Peroxidase-Oxidase in *Drosophila melanogaster* Genetic Control of (Corrado Baglioni), 1084
Tryptophan Peroxidase-Oxidase Enzyme System Specificity of the (Dr R H Marchant), 1711
Tschamler, H , and others Coal Science (Chemical Reactions of Coal—Acetylation), 412
Tschernezky, W Age of *Carcharodon megalodon*?, 1331
Tschoegl, N W Structure and Chemistry of Proteins (Surface Chemical Properties of various Cereal Proteins), 1277
Tsetse Fly Tissue Culture Development of *Trypanosoma vivax* to the Infective Stage in (Dr William Trager), B A 30
Tube (Roller) Tissue Cultures Use of Transparent Cellular Film for (John A Sharp), 1508
Tubercle Bacilli (Bovine Type) Nicotinamidase in *Mycobacteria*—a Method for Distinguishing, from other *Mycobacteria* (Dr Kiyoshi Konno, Dr Hideo Nagayama and Dr Sutemi Oka), 1743
Tubes (Narrow) The Flow of Blood through (Prof M Reiner and Dr G W Scott Blair), 354
Tubes (Pollen) Effect of Gibberellin on the Growth of (Nanda Bose), 1577
Tubing (Coated), as Columns for Gas Chromatography Use of (Prof Albert Zlatkis and H R Kaufman), 2010
d-Tubocurarine Chloride Increase by Chlorothiazide of the Paralysing Activity of (Prof W Ferrari, G L Gessa and G Sangiorgi), 1235
D-Tubocurarine Chloride Induced Tolerance to, in the Cat (Fiona Acheson and Dr R J M Fry), 1409
Tubules (Seminiferous), of the Rat Residual Bodies of (B V Kingsley Smith and Dr D Lacy), 249
Tuck, J L Ionization Phenomena in Gases (Recent Work on *Scylla*), 1355
Tucker, Prof D G Introductory Electronics, *review*, 751
  Modern Network Theory in Electrical Engineering (Networks with Parameters varying with Time), 1691
Tucker, Prof D G , and others Awarded the Brabazon Premium of the British Institution of Radio Engineers, 857
Tucker, Dr Den[illegible] W Eel Migration, 1281
Tuey, Dr G A P Gas Chromatography (Sale of Standardised Materials for Use as Stationary Phases), 328
Tufaceous Limestone near Udaipur Pollen of *Acacia* from (T Trivedi), 123
Tulecke, W J , and others Plant Growth Regulation (Isolation of a New Acid from Coconut Milk), 600
Tulpule, P G Biochemical Research in India (Species Specificity in the Mechanism of Pyridine Nucleotide Synthesis by Erythrocytes), 1368
Tumour (Ehrlich Ascites) Ribonucleases of Mouse Tissues and of the (K A O Ellem, J S Colter and Jeanne Kuhn), 984
Tumour Blood Supply A Rapid Method for studying, using Systemic Dyes (Dr R J Goldacre and Dr B Sylvén), 63
Tumour-Cell Cultures in Contact with Lysozyme Appearance of Granules in the Cytoplasm of (Dr Carlo Callerio), 202, *erratum*, 508
Tumour Cells induced by Polyoma Formation of Different Cell–Virus Relationships in (Dr Leo Sachs and Ernest Winocour), 1702
Tumour Cells (Intact Ascites) Efficiency of the Mitochondrial Oxidative Phosphorylations in (Dr P Emmelot and C J Bos), 2024
Tumour Cells (Mouse Ascites) Growth Inhibition of, by Powdered Tragacanth (Tragacanthae Pulvis, B P), (Dr E M F Roe), 1891
Tumour Growth Inhibition of, with 2 5-Dicarbethoxy-3 4-Dihydroxy-Thiophene (Dr M B Sahasrabudhe, M V Narurkar, L B Kotnis, B D Tilak and M D Bhavsar), 201
Tumour Incidence Latent Period of X-Ray Induced Ageing—a Study based on Mortality Rate and (Dr H I Kohn and Dr P H Guttman), 735
Tumour Induction (Crown Gall) A Possible Role of Indoleacetic Acid Oxidase in (Dr Jacques Lipetz), 1076
Tumour Production in Plants by Plant Extracts (Dr Archana Sharma), 1083
Tumour Specificity and Immunological Suppression (Elaine Levi, A M Schechtman, Richard S Sherins and Stanley Tobias), 563
Tumour-Susceptibility Factor in Eggs Differentiation between a Growth-Promoting Factor and a (Charles H Hill and Henry W Garren), 824
Tumour Tissue (HeLa) Production of Serum Albumin and of Globulins by Chick Mesenchymal Tissue and by, in Culture (Y Abdel-Samie, Prof. E Broda G Kellner and W Zischka), 361, *erratum*, 943
Tumour Virus (Parotid) (Polyoma Virus) Antibody Status of Mice and Response of their Litters to (Lloyd W Law, Clyde J Dawe, Wallace P Rowe and Janet W Hartley), 1420
Tumour-bearing Rats Behaviour of Zinc and Radiozinc in (Dr D M. Taylor), 1649
Tumourigenesis in Ovaries of Mice transplanted to the Liver, Kidney and Adjacent Tissues (Dr Mary J Guthrie), 916
Tumours (Bone) An Effect of Dose Fractionation on the Incidence of, using Radioactive Phosphorus (Dr N M Blackett), 565
Tumours (Polyoma-induced) Influence of Adult Lymphoid Tissues on (Dr V Defendi and Dr H Koprowski), 1579
Tumours (Transplanted), in the Mouse Effect of Bacillus Calmette-Guérin Infection on (Dr Lloyd J Old, Dr Donald A Clarke and Dr Baruj Benacerraf), 291
Tunisia Soil Salinity Course in (Prof W R van Wijk), 1778
Tunnel (Hypersonic Gun) Measurement of the Effects of Piston Mass and Bursting Pressure on the Motion of a Piston in a (B J Belcher), 1207
Tunnell, G A World Distribution of Atmospheric Water Vapour Pressure, B A 15
Turbulence A Spectrum of, at Very High Reynolds Number (H L Grant, A Moilliet and Prof R W Stewart), 808
Turian, Gilbert (Cantino, Prof Edward C , and) *Gamma* Particles, Nadi-Positive Mitochondria, and Development in the Water Fungi *Blastocladiella* and *Allomyces*, 1889
Turk, Dr F A Beitrage zur Neotropischen Fauna, *review*, 1177
Turkey Poults Effect of Thioctic Acid on Gain in Body-Weight by (J R Jowsey, R M Blakeley and H I MacGregor), 1323
Turkish-Cypriot Woman A Haemoglobin with Unusual Alkaline-denaturation Properties in a (Dr J E O'N Gillespie, Dr J C White, M J Ellis, Dr G H Beaven, W B Gratzer, Dr E M Shooter and R M E Parkhouse), 1876
Turnbull, A H , and others Atomic Weight of Silver, 358
Turnbull, David (edited by Frederick Seitz and) Solid State Physics, Vols 4, 5 and 6, *review* by Prof E C Stoner, 1753
Turnbull, Dr J H Energy Transfer with special reference to Biological Systems (Energy in the Biological Systems—Properties of Adenosine Triphosphate), 690
Turner, A (Clarke, Prof E , and) *Obituary* of Prof G O Sherrard, 1531
Turner, Dr B L (Alston, Dr R E and) Applications of Paper Chromatography to Systematics—Recombination of Parental Biochemical Components in a *Baptisia* Hybrid Population, 285
Turner, D W Gas Chromatography (New Detector employing changes of Dielectric Constant), 328
Turner, Prof E E Retirement as head of the Department of Chemistry at Bedford College, 1913 work of, 1913
Turner, E G , and Feinberg, J G Retentate, a New Scientific Term, 1139
Turner, Dr H D Robert Hooke and Boyle's Air Pump, 395
Turning Points in Physics, a Series of Lectures given at Oxford University in Trinity Term, 1958 (Dr R J Blin-Stoyle, Dr D ter Harr, Dr K. Mendelssohn, Prof G Temple, F Waismann and Prof D H Wilkinson), *review* by G R Noakes, 1090
Turnip Yellow Mosaic Virus Nucleoprotein Particles with Differing Biological and Physical Properties (R E F Matthews), 530
Turrill, Dr W B The Royal Botanic Gardens, Kew, *review* by Dr Richard A Howard, 1345
  The Genus *Oenothera*, *review*, 1974
Tutin, Prof T G Another Debt to Darwin, *review*, 129
  Hutchinson's 'Families', *review*, 1759
Tutin, Prof T G , and others Excursion Flora of the British Isles, *review* by P Falk, 1093
Tutin, Mrs T G (Dr W Pennington) Relict Fauna of Ennerdale Water —a Problem of Distribution, 1421
Tuzson, J Paper Chromatography of Corticosteroids at Room Temperature, 1937
Twinning of Crystals (International Mineralogical Association Symposium on), 1910
Twiss, Dr R Q , and others Fluctuations in Photon Streams, 967
Twitch Changes in Fluorescence in a Frog Sartorius Muscle following a (Prof Britton Chance and Frans Jobsis), 195
Two Cultures and the Scientific Revolution (Sir Charles Snow), 295 , (Dr W L Sumner), 411

Two-Dimensional High-Voltage Paper Electrophoresis of Amino- and other Organic Acids (Dr D Gross), 1298
Two-Dimensional Paper Chromatographic Method (A New), applied to the Separation of Amino-acids (C S Knight), 1486
Two-Dimensional System for the Separation of Amino-Acids and Peptides on Paper (Virginia Richmond and Brian S Hartley), 1869
Two Enzymic Mechanisms for Hydrogen Transport by Phenolic Œstrogens (Dr H G Williams-Ashman, M Cassman and Margaret Klavins), 427
Two Threats to Broadcasting—Political and Commercial Control (H Carleton Greene), 661
Two Unorthodox Primaries Colour-Image Synthesis with (Arthur Karp), 710
Tyas, J P I, and others Measurement of Cosmic Noise at Low Frequencies above the Ionosphere, 785
Tye, Arthur, and others Effect of the Potassium Salt of Gibberellic Acid on the Growth and Reproduction Rate of *Paramecium multimicronucleatum*, 1405
Tye, R P Special Ceramics (Measuring Thermal Conductivity), 116
Tyneside Association of Libraries for Industry and Commerce, 25
Type of Metabolism Importance of the, for the Radiosensitivity of Mice (Dr M Pospisil and Dr L Novak), 1814
Type-determining Phages of *Salmonella typhy* Mutation in the (E S Anderson), 1822
Type-specific Polysaccharides (Group and) of Group *D* Streptococci (Dr S D Elliott), 1342
Types of Seed A Quick Method for Extracting Plant Embryos from certain (M D Gwynne), 1588
Types and Formats (Printing) Effects of, on the Comprehension of Scientific Journals (E C Poulton), 1824
Types (Various), of Acquired Resistance to Experimental 'Allergic' Encephalomyelitis (G J Svet-Moldavsky, I A Svet-Moldavskaya and L I Raffkina), 1552
Typing (Bacteriophage), applied to Strains of *Brucella* Organisms (Prof G C van Drimmelen), 1079
Tyrrell, A C, and others Isotopic Composition of Boron, 185
Tyrrell, Dr D A J Interferon produced by Cultures of Calf Kidney Cells, 452
Tysarowski, Wieslaw, and Kwiek, Stanislaw Difference between the Catalases of Acid-fast Bacilli, 1513
Tyzzer's Disease of Mice Pure Culture of the Pathogenic Agent of (Dr K Kanazawa and A Imai), 1810
Tzevegmid, D The Mongolian Wild Horse, *Equus przewalskii*, 1025

UBBELOHDE, Prof A R Thermodynamics (Phase Changes in Condensed Systems), 1609
Übersfeld, J Coal Science (Spectroscopy of Coals—Interaction between Protons and Free Radicals in Coals of Low Rank, Exchange Interaction in Coals of High Rank), 413
Ubiquinone Levels in Rat Liver Mitochondria Pantothenic Acid Deficiency and (A S Aiyar, G A Sulebele, D V Rege and A Sreenivasan), 1867
Ubiquinone and Vitamin E (Dr Thomas Moore), 607
Uchibayashi, Masao, and others Microbiological Transformation of a Cardiac Aglycone, 469
Uchida, Kengo, and others Reductive Photo-bleaching of Eosine—Effect of Added Substances on the Rate of Reductive Photo-bleaching, 1620
Udagawa, S Clay Minerals (Relationship between the Mineralogical Constitution and the Firing Properties of Clays), 779
Udaipur Pollen of *Acacia* from Tufaceous Limestone near (T Trivedi), 123
Uemura, Prof Teijiro (Higuchi, Masataka, and) Release of Nucleotides from Yeast Cells 1381
Uganda, East Africa *Stomoxys* Control in (H C M Parr), 829
Uganda Swamp Soil Nitrogen Fixation in a (E A Calder), 746
Uhler, J, and others A New Method for Studying the Functioning of the Lungs, 372
Ullberg, S, and others Fate of Injected Dextran Labelled with Tritium in Mice, 373
Ulmer, R E, and others Relation of Ethanol Metabolism to Several Factors in the Rat, 1721
Ulothrix Effects of Auxin and Gibberellic Acid on Growth of (Dr Herbert Conrad, Dr Paul Saltman and Dr Richard Eppley), 556
Ulrich, Frank (Mahesh, Virendra B, and) Distribution of Enzyme Systems responsible for Steroid Metabolism in Different Tissues and Subcellular Fractions 1147
Ultracentrifugation and Staining of *Hevea* Latex (G F J Moir), 1626
Ultrasonic Absorption of Acetic Acid at 450 kc /s by the Calorimetric Method (S Parthasarathy and V N Bindal), 631
Ultrasonic Barium Titanate Adhesion and Paste Transducers (Dr A Lutsch), 1458
Ultrasonic Vibrations at 10,000 Megacycles (Dr E H Jacobsen), *erratum*, 27
Ultrasonic Waves in Liquids Propagation of (Prof A K Dutta, M Subudhi and K Samal), 352
Ultrasonically Dispersed Sodium (M W T Pratt and R Helsby), 1694
Ultrasound Effect of, on the Protein of Human Serum Denatured with Tannin (Dr Wizold Mizgalski and Irena Zygmunt), 1486
Ultrastructure Comparative Studies in (Linnean Society of London Symposium on), 1445
Ultra-structure of the Myoneural Junction in Myasthenia Gravis (E R Bickerstaff, J V Evans and A L Woolf), 1500
Ultra-violet Absorption of Deoxyribo- or Ribo-Nucleic Acids Comparative Effects of Heat on Chromatography and (Dr Saul Kit), 36
Ultra-Violet Absorption Maxima and the Electronegativity of the Adjacent Atoms in some Aliphatic Carbonyl Compounds A Correlation between the Shift in the (Dr P Borrell), 1932
Ultra-Violet Irradiation Effect of, on Transduction in *Pseudomonas aeroginosa* (J S Loutit), 1960
  Photoautomerization of Cytosine Derivatives on (Shih Yi Wang), 184
  Production of a Perfect Stage in a Nutritionally Deficient Mutant of Pathogenic *Fusarium oxysporum* after (E W Buxton), 1258
Ultra-violet Irradiation of 1,3,-Dimethylthymine (Shih Yi Wang), B A 59
Ultra-Violet Light Annealing of Recoil Damage by (R F C Claridge and Dr A G Maddock), 1932
  Macromolecular Synthesis in Bacterial Recovery from (C O Doudney), 189
Ultra-Violet Lights Application of, to Underwater Research (Richard G Woodbridge, III, and Dr Richard C Woodbridge), 259
Ulyatt, M J, and others Composition of some Fat-free Carcasses and Bodies of New Zealand Sheep, 1724
Umbra of Sunspots and Enhanced Radiation on 200 Mc /s Correlation between the Intensity of the (Per Maltby), 1391
Unanaesthetized Cat Evoked Potentials in Visual Cortex of the (Gabriel Horn and John Blundell), 173
Unbalanced Growth Influence of on Subsequent X-Ray Induced Inhibition of Deoxyribonucleic Acid Synthesis in *Escherichia coli* 15_T (Daniel Billen), 174
Under-developed Countries Assistance for, 1363
  Distribution of Scientific Publications in (Scientific Publications Council Discussion on), B A 22
  Management Problems in, 483
Underdeveloped Territories Management and (Political and Economic Planning, Broadsheet No 434), 483
Under-developed Territories and their Problems, 1519
Underground Decay of a Tau-Meson (A M Short), 893
Underground Test Explosions in Britain 1532
Understanding Concerning Human (Prof Nikunja Vihari Banerjee), *review* by Dr D J McCracken, 1571
Underwater Research Application of Ultra-Violet Lights to (Richard G Woodbridge, III, and Dr Richard C Woodbridge) 259
Unesco Vegetation Map of Malaysia, including New Guinea (compiled by C G G J van Steenis), 27
  Educational Studies and Documents No 30, Technical and Vocational Education in the U S S R (M I Movšovič), 504
Unesco (American Association for the Advancement of Science and) International Oceanographic Congress, 1605
Unesco (Indian Council of Agricultural Research and) International Symposium on Algology, 595
Unesco and the International Atomic Energy Agency Appeal for help to reconstruct the Library of the Brazilian Centre for Physics Research, 769
Unesco, and others Symposium on the Biological Effects of Low Doses of Ionizing Radiations, 1111
Unesco Middle East Science Co-operation Office Regional Training Course on Diagnosis, Improvement and Management of Salt-affected Soils, as a part of the Arid Zone Project, 1778
Unesco South Asia Science Co-operation Office Bibliography of Scientific Publications of South and South-East Asia, Vol 5, No 6, 772
Unesco South Asia Science Co-operation Office (University Institute of Chemistry, Lahore, and the) Regional Training Course for Laboratory Technicians, 857
Unesco South Asia Science Co-operation Office, and others Course on the Use of Radioisotopes in Agricultural Research, 1451
Unexpected Formation of Volatile Compounds on Gas–Liquid Chromatography Columns (C Weurman and J Dhont), 1480
Ungstrup, Eigil Observations of 'Whistlers' and Very Low Frequency Phenomena at Godhavn, Greenland, 806
Unidentified Chick Growth Factors (J A Wakelam and W P Jaffe), 272
Unidentified Growth Factors (K A Allen, J Stephens, W P Jaffe and J A Wakelam), 271
Unifying Hypothesis The Aurora, the Radiation Belt and the Solar Wind —a (M H Rees and G C Reid), 539
Unimpaired Mitosis in Cells with Modified Deoxyribonocleic Acid (Rolla B Hill, jun, Klaus G Bensch and Donald W King), 1429
Unit Cell of Mercuripapain Crystals (J Drenth and J N Jansonius), 1718
United Kingdom Nuclear Studies in the, 235
  Strontium-90 in Human Diet in the (Agricultural Research Council), 1111
United Kingdom Atomic Energy Authority The Proton Linear Accelerator at the Rutherford High Energy Laboratory, 94
  The *Nimrod* 7,000-MeV Proton Synchrotron, B A 14
  The Tandem Generators of the (K W Allen, F A Julian, W D Allen, A E Pyrah and J Blears), 303
  Fifth Annual Report (1958-59), 602
  Zenith Reactor at Winfrith Heath, 680
  Special Promotions, 858
  Grant not exceeding £5,700 to the University of Oxford, for studies in interferometric spectroscopy, and a further grant not exceeding £1,250, for work on the constitution of bismuth-rich alloys, 943, 1273
  Thermonuclear Programme, 1106
  To purchase a Nuclear Source Thermal Reactor (*Nestor*) from the Hawker Siddeley Nuclear Power Co, 1533
  Grant of £8,500 to the University of Oxford, for a study of polarized nuclear systems using resonance techniques, 1535
  A Record of the Proceedings of the Symposium on Glove Box Design and Operation held in the Cockcroft Hall, A E R E, 1957 (Glove Boxes and Shielded Cells for Handling Radioactive Materials, edited by G N Walton), *review*, 1599
United Kingdom Atomic Energy Authority (United States Atomic Energy Commission and the) To exchange Technical Information on Advanced Gas-cooled Reactors, 1361
United Kingdom Civil Service Commission, 1278
United Kingdom High Commissioner in New Delhi Appointment of Dr H R Ambler as scientific adviser to the, 1448
United Kingdom Petroleum Industry Statistics relating to Consumption and Refinery Production, 1957 and 1958 (Petroleum Information Bureau), 855
United Nations Demographic Yearbook 1958 (Special Topic, Marriage and Divorce Statistics), *review*, 1525
  Economic Developments in the Middle East, 1957-1958 (Supplement to World Economic Survey, 1958), 1280
United Nations (Food and Agriculture Organization) Report of the Food and Agriculture Organization Nutrition Meeting in Europe, Rome, 1958, 407
  World Meeting on Veterinary Education, 943
United Nations (Food and Agriculture Organization), and others Course on the Use of Radioisotopes in Agricultural Research, 1451
United Nations (Food and Agriculture Organization and the World Health Organization) School-Feeding Seminar for countries in South and East Asia, 420

United Nations (World Health Organization) Technical Report Series No 154, Post-Graduate Training in the Public Health Aspects of Nuclear Energy (Fourth Report of the Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel), 33
  Technical Report Series No 171, Mental Health Problems in Old Age, 1844
United States Education in the (1957-58), 418
  Geochemical Research in the, *review* by Dr S R Nockolds, 1757
  Progress of Public Education in the (1957-58), 418
  Trends in Birth Rates in the, since 1870 (Dr Bernard Okun), *review*, 134
United States, Science Advisory Committee to the President of the Report on Education for the Age of Science 81, 87
United States and Great Britain to exchange Data on Advanced Gas-cooled Reactors, 1361
United States Air Force Cambridge Research Center Conference on Silicon Carbide, 158
United States Air Force Cambridge Research Center (Electronics Research Directorate) Conference on Extremely High Temperatures, Boston 1958 (edited by Dr Heinz Fischer and Lawrence C Mansur), *review* by Dr T E Allibone, 83
United States Air Force Cambridge Research Center (sponsored by the Geophysics Research Directorate of the) The Threshold of Space—the Proceedings of the Conference on Chemical Aeronomy, Cambridge, Mass , 1956 (edited by M Zelikoff), *review*, 1011
United States Air Force Office of Scientific Research First Annual Astronautics Symposium—Vistas in Astronautics (edited by Morton Alperin and Marvin Stern), *review* by D G King-Hele, 663
United States Army Neurosurgery in the Second World War, *review* by J E A O'Connell, 1676
United States Atomic Energy Commission Hot Laboratory Equipment, new edition, 155
  Technical Books sponsored by the, 407
  Course on the Basic Techniques of Handling Radioisotopes, 771
  Amendments to the Atomic Energy Act of 1954, 853
  Report ORINS-25, The Acute Radiation Syndrome—a Medical Report on the Y-12 Accident, 1958 (compiled by Dr Marshall Brucer) 1022
United States Atomic Energy Commission and the United Kingdom Atomic Energy Authority To exchange Technical Information on Advanced Gas-cooled Reactors, 1361
United States Coast and Geodetic Survey To erect a Geodetic Marker at the South Pole, 1612
United States Embassy in India Appointment of Prof E C Watson as scientific attaché to the, 1686
United States Expenditure on Research and Development in 1957, 1022
United States Geological Survey Suggestions to Authors of the Reports of the, fifth edition, *review* by Prof C F Davidson, 390
  Bulletin 1064, Systematic Mineralogy of Uranium and Thorium (Prof Clifford Frondel), *review* by Prof C F Davidson, 675
United States National Academy of Sciences Election of foreign associates, 95
United States National Academy of Sciences—National Research Council Conference on the Atomic Mechanisms of Fracture, 324
  Report for 1957-58, 697
  Developmental Biology Conference Series, 1956—Cytodifferentiation (edited by Dorothea Rudnick) , Environmental Influences on Prenatal Development (edited by Beatrice Mintz) , Regeneration in Vertebrates (edited by Charles S Thornton) , Embryonic Nutrition (edited by Dorothea Rudnick) , Immunology and Development (edited by M V Edds, Jr) , Dynamics of Proliferating Tissues (edited by Dorothy Price) Wound Healing and Tissue Repair (edited by W Bradford Patterson), *review* by Dr D R Newth, 839
  Grants-in-aid for Research in Problems of Sex, 1107
United States National Academy of Sciences–National Research Council (Committee on Fire Research and the Fire Research Conference of the Division of Engineering and Industrial Research) Symposium on the Use of Models in Fire Research, 772
United States National Academy of Sciences and the Academy of Sciences of the U S S R Exchange visits by research scientists of each country, 680
United States National Bureau of Standards *Journal of Research* to be published in four separate Sections, 320
  Handbook 69, Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure, 939
United States National Institutes of Health Ninth Annual Instrument Symposium and Research Equipment Exhibit, 26
United States National Institutes of Health (Endocrinology Study Section) Free distribution of Pituitary Hormones, 1272
United States National Radio Astronomy Observatory Appointment of Prof Otto Struve as first director, B A 14
United States National Research Council (National Academy of Sciences) Conference on the Atomic Mechanisms of Fracture, 324
  Report for 1957-58, 697
  Developmental Biology Conference Series, 1956—Cytodifferentiation (edited by Dorothea Rudnick) , Environmental Influences on Prenatal Development (edited by Beatrice Mintz) , Regeneration in Vertebrates (edited by Charles S Thornton) , Embryonic Nutrition (edited by Dorothea Rudnick) , Immunology and Development (edited by M V Edds, Jr) , Dynamics of Proliferating Tissues (edited by Dorothy Price) , Wound Healing and Tissue Repair (edited by W Bradford Patterson), *review* by Dr D R Newth, 839
  Grants-in-aid for Research in Problems of Sex, 1107
United States National Research Council (Committee on Fire Research and the Fire Research Conference of the Division of Engineering and Industrial Research of the National Academy of Sciences) , Symposium on the Use of Models in Fire Research, 772
United States National Science Foundation Grant of 250,000 dollars to the United States Naval Research Laboratory, for rocket observations of ultra-violet and X-ray emissions from solar flares, 406
  Reviews of Data on Research and Development No 13, Research and Development and Economic Growth (Dr A T Waterman), 591
  To establish and maintain a Programme of National Information on Scientific and Technical Personnel, 592
  Resignation of Dr David D Keck as acting director of the New York Botanical Garden in order to remain permanently as programme director for systematic biology at the Foundation's Division of Biological and Medical Sciences, 680
  Grant of 250,000 dollars to the Woods Hole Oceanographic Institution, 683
  Grant of 171,600 dollars to the Bernice P Bishop Museum, Hawaii, 683
  Grant of 162,000 dollars to the Marine Laboratory, University of Miami, 683
  Grant of 155,000 dollars to the California Institute of Technology, 683
  Grant of 150,000 to the University of Chicago, 683
  Grant of 135,000 dollars to the Long Island Biological Association, 683
  Grant of 105,000 dollars to the Woods Hole Marine Biological Laboratory, 683
  Formation of an Advisory Panel on Atmospheric Sciences, 1022
  Reviews of Data on Research and Development, No 14, Funds for Research and Development Performance in American Industry, 1022
  Reviews of Data on Research and Development, No 15, Grants for Private Philanthropic Foundations during 1957, 1272
  Post-doctoral Fellowships, 1534
  Providing United States Scientists with Soviet Scientific Information, revised edition, 1611
  Appointment of Dr Bowen C Dees as assistant director for scientific personnel and education, 1686
  Grant of 3,000,000 dollars to the Woods Hole Oceanographic Institution, for a new Research Vessel, 1686
United States Naval Research Laboratory Grant of 250,000 dollars from the United States National Science Foundation, for rocket observations of ultra-violet and X-ray emissions from solar flares, 406
United States Office of Naval Research Second Conference on Semiconductor Surfaces, 1192
United States Public Health Service Grant of 14,160 dollars to the University of Oxford, for the continuation of research on vision and light quanta, 943, 1273
  Grant of 30,600 dollars to the University of Oxford, for research in the Department of Biochemistry, 1362
United States Rubber Co Foundation of a second postgraduate research studentship at University College of North Staffordshire, 322
United States Scientists Providing, with Soviet Scientific Information (United States National Science Foundation), revised edition, 1611
United States Scientists (Soviet and) Exchanges between, 680
United States Society of Protozoologists Election of Officers for 1959-60, 1272
United Steel Companies, Ltd Appointment of Dr K J Irvine as deputy research manager, 95
  Appointment of J D Murray as head of the Applied Metallurgy Section, 95
  Appointment of F B Pickering as head of the Physical Metallurgy Section, 95
Units Atomic (Prof H Shull and Dr G G Hall), 1559
U T $+\Delta T$ An Error in the Determination of ΔT from the Lunar Ephemeris and the Frequency of Caesium in Terms of (C A Murray), 441
Universe (The Steady-Rate), and the Deduction of Continual Creation of Matter (Prof V A Bailey), 537 , (Prof G Bondi), 537
Universities The—a Royal Commission ? (G C Moodie), 1432
Universities of the British Commonwealth, Association of Commonwealth Universities Yearbook, 1959, *review*, 577
Universities of the Commonwealth Report of Proceedings of the Eighth Congress, Montreal 1958, 1431
Universities (British) Scientific Research in, 1958-59 (British Council), 854
Universities (Expanding) Administrative Problems in (Home Universities Conference 1959), 1613
Universities Conference Home (1959), 1613
Universities Council for Adult Education Report for 1957-1958, 331
Universities Film Council (British), (Dr J Horne), 330
  Discussion on the Visual Illustration of University Lectures, 515
Universities Yearbook Commonwealth, 1959 (Association of Universities of the British Commonwealth), *review*, 577
University New (Prof Jack Simmons), *review* by Sir John Wolfenden, 1975
University of Birmingham The Graduate School in Mathematical Physics (Prof R E Peierls), 96
  Retirement of Prof G F Mucklow from the Chance chair of mechanical engineering, 502
  Appointment of Dr S A Tobias to the Chance chair of mechanical engineering, 502
  Appointment of Dr S V Perry as professor of biochemistry, 679
  Title of professor of analytical chemistry conferred on Dr Ronald Belcher, 679
  Title of professor of mathematical physics conferred on Dr G E Brown, 679
  Appointment of Prof J Heslop Harrison to the chair of botany, 684
  Appointment of Dr Brenda Manly and Dr J Cohen as lecturers in zoology, 684, 1362
  Appointment of K A Redish as lecturer in mathematical physics, 684, 1362
  Appointment of Dr N A Dyson as lecturer in physics, 684, 1362
  Appointment of Dr F J Wallace as lecturer in mechanical engineering, 684
  Appointment of Dr I R Smith as lecturer in electrical engineering, 684, 1362
  Appointment of Dr V G Jenson as lecturer in chemical engineering, 684, 1362
  Appointment of Dr W B Morgan as lecturer in geography, 684
  Appointment of R S Hall as Research Fellow in physics, 684
  Appointment of E A Howson as Research Fellow in electrical engineering, 684
  Appointment of R D Hartley as Research Fellow in mining, 684
  Appointment of E Whipp as G E C Hirst Fellow in the Department of Electrical Engineering, 684
  Appointment of A T Aldred as Research Fellow in physical metallurgy, 684
  Appointment of D W Jones as Research Fellow in physical metallurgy, 684
  Appointment of Dr J Kolbuszewski to the chair of highway and traffic engineering, 939
  Appointment of Dr M E Davies as lecturer in botany, 1026, 1362
  Appointment of Dr C R Sladden as lecturer in biology, 1026, 1362

  Appointment of Dr D J Blundell as lecturer in geology, 1026, 1362
  Appointment of K B Haley as lecturer in engineering production, 1026, 1362
  Appointment of Dr N A J Rogers as lecturer in chemistry, 1026, 1362
  Appointment of P W Dykes as lecturer in medical biochemistry and experimental pathology, 1026
  Third 'Joining of Metals' Conference (The Electric Arc in Welding), 1030
  Title of reader in mathematical physics conferred on Dr J G Valatin, 1362, 1688
  Appointment of Dr H B Griffiths as lecturer in pure mathematics, 1362, 1688
  Appointment of Dr J K Brown as lecturer in chemistry, 1362, 1688
  Appointment of Dr Nancy Montgomery as lecturer in botany, 1362
  Annual Lecture of the Institute of Education to be named 'The Raymond Priestley Lecture', 1362
  Plans for a building for highway and traffic engineering, 1362
  Appointment of Dr D A Bell and J T Allanson as joint acting heads of the Department of Electrical Engineering, 1688
  Joseph Lucas, Ltd , to finance a Fellowship in the field of metal joining in the Department of Industrial Metallurgy, 1688
  Research Fellowship in zoology awarded to Dr Florence J Pepper, 1688
  Research Fellowship in genetics awarded to Prof L P V Johnson, 1688
  Research Fellowship in physics awarded to M J Harrison, 1688
  Research Fellowship in biochemistry awarded to H Mueller, 1688
  Conference on Modern Network Theory in Electrical Engineering, 1691
  Appointment of Dr A P D Thomson as acting director of the Department of Anatomy, 1915
  Appointment of Dr D S Urch as lecturer in chemistry, 1915
  Appointment of J C Maltback as lecturer in mechanical engineering, 1915
  Appointment of G C-Y Hu as lecturer in highway and traffic engineering, 1915
  Appointment of G H J Bennett as lecturer in industrial metallurgy, 1915
  Appointment of Dr C G Wall as lecturer in chemical engineering, 1915
  Appointment of R H Jones as assistant lecturer in civil engineering, 1915
  Appointment of P J Waterton as Staff Fellow in physics, 1915
  Appointment of Dr V Knapp as Research Fellow in nuclear physics, 1915
  Appointment of Dr M Gage as Research Fellow in geology, 1915
  Appointment of M H B Hayes as I C I Fellow in chemistry, 1915
  Appointment of Dr J P Simons as Fellow in chemistry, 1915
  Appointment of D W Thomas as National Coal Board Research Fellow in physical chemistry, 1915
University of Birmingham (Department of Civil Engineering and the Department of Extra-Mural Studies) Course on River Pollution Sewage Disposal and Trade Waste Treatment, 1451
University of Bristol Appointment of Dr W M Shepherd to the chair of theoretical mechanics 322
  Appointment of P W Bothwell as lecturer in public health, 322
  Appointment of D R Coles as lecturer in medicine, 322
  Appointment of D G Osmond as lecturer in anatomy, 322
  Appointment of R Park as lecturer in civil engineering, 322
  Appointment of N G Sanerkin as lecturer in pathology, 322
  Appointment of Dr J T Martin to a readership in chemistry of insecticides and fungicides, 410
  Lectureship in inorganic chemistry conferred on Dr E W Abel, 410
  Lectureship in electrical engineering conferred on Dr R F Burbridge, 410
  Lectureship in chemical pathology (veterinary) conferred on R H C Penny, 410
  Appointment of Dr J W Barton as lecturer in organic chemistry, 1613
  Appointment of Dr D L Dineley as lecturer in geology, 1613
  Appointment of Dr K R Gough as Research Fellow in medicine, 1613
  Appointment of Dr S Griew as lecturer in psychology, 1613
  Appointment of Dr M A Hollingsworth as lecturer in mechanical engineering, 1613
  Appointment of B S Smith as lecturer in civil engineering, 1613
  Appointment of D J Storey as lecturer in electrical engineering, 1613
  Appointment of Dr C J Waddington as lecturer in physics, 1613
  Grants from the Department of Scientific and Industrial Research—£16,680 to the Department of Physics, for research in cosmic radiation with balloons, photon-induced cascades at different altitudes, and time variations in the primary cosmic radiation over Great Britain , £35 084 to the Department of Psychology, for research into the complexity of industrial tasks , to the Department of Geology, £5,000 for investigations of feldspars in the Connemara granite series and preferred orientation in rock-forming minerals, and £3,550 for investigations of the submarine geology of the continental shelf of the Western Approaches of the English Channel , £3,850 to the Department of Physical and Inorganic Chemistry, for equipment , and £2,880 to the Department of Zoology, for investigations of the physiological basis of behaviour in protozoa, 1613
  Grant of £1,150 from the National Coal Board to the Department of Physical and Inorganic Chemistry, for a study of carbon surfaces and surface complexes by infra-red spectroscopy, and £1,100 for a study of reactivity of carbon surfaces with oxygen, 1613
  Grant of £1,150 from the Ministry of Supply to the Department of Electrical Engineering, for research on noise generation in inductors with ferromagnetic cores (continuation of grant), 1613
University of Calcutta Hundred Years of the—Supplement, *review* by Dr R S Aitken, 218
University of California Establishment of a Department of Virology, 26
  Appointment of Dr Wendell M Stanley as chairman of the Department of Virology, 26
University of Cambridge Formation of a Department of Applied Mathematics and Theoretical Physics 686
  Appointment of Dr G K Batchelor as first head of the Department of Applied Mathematics and Theoretical Physics, 686
  Honorary degree of M A conferred on G R Crowe, 1108
  Appointment of Dr J M Thoday to the Arthur Balfour chair of genetics, 1189
University of Cambridge (Engineering Department), (British Welding Research Association and the) Symposium on Fatigue of Welded Structures, 1915
University of Cambridge Post-Graduate Medical School Symposium on Depression, 322
  Symposium on Haematology, 1192
University of Chicago Grant of 150,000 dollars from the United States National Science Foundation, 683
  Awards for Study in Statistics, 772
University of Dublin Appointment of Dr A L Kapoor as an I C I Fellow in chemistry at University College, 410
University of Durham Retirement of Prof J C Prescott from the chair of electrical engineering in King's College, Newcastle-upon-Tyne, 404
  Appointment of Dr R L Russell to the chair of electrical engineering in King's College, Newcastle-upon-Tyne, 404
  Appointment of Dr D A Wright as first professor of applied physics, 1022
University of Edinburgh Retirement of Prof A D Ritchie as professor of logic and metaphysics, 156
  Appointment of Prof E E Harris as acting head of the Department of Philosophy, 156
University of Glasgow Retirement of Prof W M Smart as regius professor of astronomy, 23
  Appointment of Dr P A Sweet as professor of astronomy, 23
  Report of the Appointments Committee for the Year 1958, 1026
  Election of Viscount Hailsham as Rector, 1915
  New Engineering Building inaugurated by Viscount Montgomery of Alamein, 1915
  Appointment of R E Azuma and W R Hogg as lecturers in experimental and theoretical physics, 1915
  Appointment of Helen S Dunsmore and G S Harris as lecturers in chemistry, 1915
  Appointment of W Graham Jardine as lecturer in geology, 1915
  Appointment of J Leech as lecturer in the computing laboratory, 1915
  Appointment of A Bhati, A C Day, W J McMaster and W Parker to research fellowships in chemistry, 1915
  Appointment of J D Roycroft to a research fellowship in solid state physics, 1915
  Appointment of Wm C Russell to a research fellowship in virology (first Lock fellowship), 1915
University of Graduate Studies (Dr Detlev W Bronk), 86
University of Hull Annual Report for 1957-58, 237
  Retirement of Prof R D'O Good from the chair of botany, 853
  Appointment of Dr N F Robertson to the chair of botany, 853
  Grant of £6,000 from the Department of Scientific and Industrial Research to the Department of Chemistry, towards the purchase of a mass spectrometer, 1273
  Grant of £4,900 from the Nature Conservancy to the Department of Geography, for an investigation into the coastal geomorphology of Holderness and Spurn Head, 1273
  Appointment of F J Bryant as lecturer in physics, 1273
  Appointment of I C Williams as lecturer in zoology, 1273
University of Leeds Eighty-fourth Report of the Textile Industries and Dyeing Advisory Committee on the work of the Departments of Textile Industries and Colour Chemistry and Dyeing (1957-58), 155
  Appointment of Dr J H Western to the chair of agricultural botany, 405
  Appointment of A W Chronowicz as lecturer in civil engineering, 684
  Appointment of Dr B F Salvage as lecturer in electrical engineering, 684
  Appointment of A L Yettram as lecturer in civil engineering, 684
  Appointment of Dr G G Haselden to the new chair of chemical engineering, 1106
  Grants from the Department of Scientific and Industrial Research—£1,835 to the Department of Physics, towards the cost of cosmic-ray research , £12,000 to the Department of Chemistry, for an investigation into high-pressure chemistry and geochemistry , £3,000 for research by Dr P Gray in physical chemistry , and £1,500 for research in high alumina cements, 1108
  Grant of 6,000 dollars for two years from W R Grace and Co , for a research fellowship in physical chemistry, 1108
  Grant of £1,422 from the Marine Biological Association, for research on the electron microscopy of marine flagellates, 1108
  Grant of £3,000 from the National Coal Board (North-Eastern Division), and a grant of £1,000 from Richard Sutcliffe, Ltd , for research in mining, 1108
  Grants of £1,893 from the Agricultural Research Council, for two research projects in the Department of Agriculture, and £2,807 to the Department of Anatomy, for research into the interpretation of fibre types in sheep, 1108
  Appointment of D I Davies as a lecturer in the Department of Organic Chemistry, 1108
  Appointment of A R J Gaskin as a lecturer in the Department of Geology, 1108
  Appointment of A N Hillas as a lecturer in the Department of Physics, 1108
  Appointment of M D Longfield as a lecturer in the Department of Mechanical Engineering, 1108
  Appointment of A R Mathieson as a lecturer in the chemistry of high polymers in the Department of Textile Industries, 1107
  Grant of £4,310 from the National Coal Board, for six research projects in mining, 1534
  Grant of £3,860 from the Central Electricity Generating Board, for research on the utilization of pulverized fuel ash, 1534
  Appointment of Dr A F Thomas as lecturer in the Department of Organic Chemistry, 1534
  Second Symposium on Coal Preparation, Department of Mining, 1957, *review* by Prof S G Ward, 1601
University of Leicester, *review* by Sir John Wolfenden, 1975
University of Leicester Appointment of Dr E W Parkes to the new chair of engineering, 938
University of Liverpool Appointment of Dr B Collinge as reader in physics, 410
  Appointment of Dr P M Sheppard as reader in genetics, 410

  Appointment of Dr A K Holliday to a senior lectureship in inorganic and physical chemistry, 410
  Appointment of Dr N S Jones to a senior lectureships in marine biology, 410
  Appointment of Dr T M Flett to a senior lectureship in pure mathematics, 410
  Appointment of Dr A Ashmore to a senior lectureship in physics, 410
  Appointment of Dr H D Parbrook to a senior lectureship in physics–acoustics, 410
  Appointment of Dr V H Leck to a senior lectureship in electronic engineering, 410
  Appointment of Dr R S Benson and Dr N G Calvert to senior lectureships in mechanical engineering, 410
  Appointment of Dr F T W Jordan to a senior lectureship in veterinary preventive medicine, 410
  Computer Laboratory at the, 1537
University of London The Sir John Atkins Laboratories at Queen Elizabeth College, 26
  Extension to the Chester Beatty Research Institute of the Institute of Cancer Research, Royal Cancer Hospital, B A 15
  Postgraduate Courses at the Imperial College of Science and Technology (1959-60), 235
  Appointment of Prof J L D'Silva to the Halliburton chair of physiology at King's College, 322, 405
  Appointment of A H J Rains to the chair of surgery at Charing Cross Hospital Medical School, 322
  Appointment of Dr G R Hilson as reader in bacteriology at St George's Hospital Medical School, 322
  Appointment of Dr D Dexter as reader in morbid anatomy at St George's Hospital Medical School, 322
  Appointment of J F Smith as reader in morbid anatomy at University College Hospital Medical School, 322
  Appointment of R E M Thompson as reader in bacteriology at Middlesex Hospital Medical School, 322
  Appointment of Dr P J Grant as reader in engineering science at the Imperial College of Science and Technology, 322
  Appointment of Dr B W Martin as reader in applied thermodynamics at the Imperial College of Science and Technology, 322
  Appointment of E M Rawstron as reader in geography at Queen Mary College, 322
  Title of reader in zoology in the University (at Birkbeck College) conferred on T E Hughes, 322
  Title of reader in psychology in the University (at Bedford College) conferred on Dr J Wynn Reeves, 322
  Title of reader in therapeutics in the University (at Guy's Hospital Medical School), conferred on Dr J H Trounce, 322
  Symposium at Queen Mary College on the Oxidation of Organic Compounds, 326
  Retirement of Prof R J S McDowall from the Halliburton chair of physiology in King's College, 405
  Appointment of Dr P Grootenhuis to the University readership in mechanical engineering at the Imperial College of Science and Technology, 508
  Title of reader in sociology in the University (at the London School of Economics and Political Science) conferred on T B Bottomore, 508
  Title of professor emeritus in the University conferred on Prof R J S McDowall, Prof Margaret M A Murray, Prof J H Woodger and Prof H J Collins, 508
  Appointment of Prof W R Niblett as dean of the Institute of Education with the title of professor of education in the University, 595
  Appointment of Dr D J Anderson to the University readership in physiology in relation to dentistry at Guy's Hospital Medical School, 595
  Appointment of Dr A Ashmore to the University readership in experimental physics at Queen Mary College, 595
  Appointment of Dr F Hobbiger to the University readership in pharmacology at Middlesex Hospital Medical School, 595
  Appointment of Dr M B Shapiro to the University readership in psychology at the Institute of Psychiatry, 595
  Appointment of J W Stewart to the University readership in haematology at Middlesex Hospital Medical School, 595
  Appointment of Dr D F Cheesman to the University readership in biochemistry at Bedford College, 595
  Appointment of Dr A P Millman to the University readership in mining geology at the Imperial College of Science and Technology, 595
  Title of professor of virology in the University (at the London School of Hygiene and Tropical Medicine) conferred on Dr Forrest Fulton, 1108
  Title of professor of epidemiology in the University (at the London School of Hygiene and Tropical Medicine) conferred on Dr D D Reid, 1108
  Title of reader in pharmaceutics in the University (at the School of Pharmacy) conferred on Dr D Train, 1108
  Title of professor of physics in the University (at the Imperial College of Science and Technology) conferred on Dr M Blackman, 1273
  Title of professor of physical chemistry in the University (at the Imperial College of Science and Technology) conferred on Dr F C Tompkins, 1273
  Title of reader in biochemistry in the University (at University College) conferred on S P Datta, 1273
  Title of reader in applied mathematics in the University (at King's College) conferred on Dr C W Kilmister 1273
  Appointment of Dr G Morton to the University readership in operational research at the London School of Economic and Political Science, 1451
  Title of professor of embryology (at University College), conferred on Michael Abercrombie, 1451
  Title of reader in chemistry (at University College) conferred on Dr D J Millen, 1451
  Title of reader in botany (at University College) conferred on P J Syrett, 1451
  Appointment of P R Bell to the University readership in botany at University College, 1535
  Appointment of A V Bradshaw to the University readership in extraction metallurgy at the Imperial College of Science and Technology, [illegible]35
  Title of professor of electrical engineering in the University (at King's College) conferred on Dr A H M Arnold, 1535
  Appointment of Dr P B D de la Mare to the University chair of chemistry at Bedford College, 1613, 1913
  Title of professor of experimental physics in the University (at King's College) conferred on Dr F C Champion, 1613
  Appointment of Dr D R Arthur as reader in zoology at King's College, 1613
  Appointment of Dr J B Hasted as reader in physics at University College, 1613
  Retirement of Prof E E Turner as head of the Department of Chemistry at Bedford College, 1913
University of London (Extra-Mural Department), (Association of Agriculture and the) Lectures on the Land of Britain—is it Used to the Best Agricultural Advantage ?, 1845
University of London Institute of Education Appointment of Prof W R Niblett as dean, with the title of professor of education in the University, 595
University of London Institute of Psychiatry Appointment of Dr M B Shapiro to the University readership in psychology, 595
University of London School of Pharmacy Title of reader in pharmaceutics in the University of London conferred on Dr D Train, 1108
University of Malaya in Kuala Lumpur (Prof R D Purchon) 306, 405
  Appointment of Prof G M Davies to the chair of agriculture, 306
  Appointment of Prof M E D Poore to the chair of botany, 306
  Appointment of Prof R A Robinson to the chair of chemistry 306, 405
  Appointment of Prof Robert Ho to the chair of geography, 307
  Appointment of Prof C J Eliezer to the chair of mathematics, 307
  Appointment of Prof J R Hendrickson to the chair of zoology, 307
  Appointment of Prof R S Huang to the chair of chemistry, 405
University of Manchester Appointment of Dr F Fairbrother as professor of inorganic chemistry, 1986
University of Melbourne David Syme Research Prize awarded to Dr J H Piddington, B A 16
University of Miami Grant of 162,000 dollars to the Marine Laboratory from the United States National Science Foundation, 683
University of Michigan Appointment of Dr Wray Smith as assistant director of the Willow Run Laboratories, 26
  Appointment of Prof Louis J Cutrona as head of the Willow Run Radar Laboratory, 26
University of Nottingham Appointment of Dr K J Standley to a readership in physics, 410
  Appointment of Dr G E Lamming to a readership in animal physiology, 410
  Appointment of Dr M Woodbine to a readership in agricultural microbiology, 410
  Meeting to discuss the formation of a Society for Forensic Science, 508
University of Nottingham (School of Agriculture) Sixth Easter School in Agricultural Science (The Measurement of Grassland Productivity), 154
University of Oxford Grant not exceeding £1,100 from the Medical Research Council for scientific assistance in a study of X-Ray analytical methods of insulin and related structures, 943, 1273
  Grant not exceeding £5,700 from the United Kingdom Atomic Energy Authority, for studies in interferometric spectroscopy, and a grant not exceeding £1,250, for work on the constitution of bismuth-rich alloys, 943, 1273
  Grant of 14,160 dollars from the United States Public Health Service, for the continuation of research of vision and light quanta, 943, 1273
  Grants from the Department of Scientific and Industrial Research—£1,000 for research on some natural products with biological activity, £1,500 for research into perceptual limitations in high-speed performance , £22,860 for an investigation of the geological age of rock series by methods based on natural radioactivity , £1,220 for equipment for research on the biochemical mechanism of cell division , £25,725 for an investigation of materials, using magnetic resonance and double resonance techniques , and £17,610 for an investigation of nuclear orientation and nuclear cooling in magnetic fields, 943, 1273
  Grant not exceeding £1,175 from the Ministry of Supply, for the continuation of an investigation of fluorocarbohydrates, 943, 1273
  The sum of £2,200 to be expended from the University General Fund on alterations to the Department of Zoology, 943
  Appointment of E F Jackson as director of the Institute of Statistics, 943
  Grant of £9,534 10s , from the Admiralty, for the continuation of research on centimetre waves and fundamental problems, 1273
  Grant of £1,200 from European Research Associates, Brussels, for research on acetylene chemistry, 1362
  Grant of £3,400 from the Department of Scientific and Industrial Research, for the maintenance of the 140 MeV synchrotron for nuclear physics research, 1362
  Grant of £2,500 for two years from the Colonial Medical Research Council, for the study of the sensory neurohistological changes in skin infected with leprosy, 1362
  Grant of £1,500 from the Smith, Kline and French Research Institute, for research on the electrophysiology and pharmacology of smooth muscle, 1362
  Grant of 30,600 dollars from the United States Public Health Service, for research in the Department of Biochemistry, 1362
  Grant of £35,900 from the Department of Scientific and Industrial Research, for research on high-energy phenomena using photographic plates, 1535
  Grant of £8,500 from the United Kingdom Atomic Energy Authority, for a study of polarized nuclear systems using resonance techniques, 1535
  Grant of £1,395 from the Ministry of Aviation, for research on the mechanisim of operation of the cryotron, 1535
  Second Tanganyika Expedition (R Davis), 1543
  Grant of £3,000 from British Petroleum Trading, Ltd , for the purpose of continuing a research fellowship in geochemistry, 1688, 1986
  Grant of 3,000 dollars from the du Pont Company, for the support of basic research in the field of theoretical chemistry, 1688, 1896

  - Grant of £8,000 from the Nuffield Foundation, for the continuation of research being carried out by H B Parry at the Nuffield Institute for Medical Research, 1986
- University of Reading Report for 1958 of the Museum of English Rural Life, 505
  - Annual Report for 1958 of the National Institute for Research in Dairying, 770
  - Grant of 89,348 dollars from the Population Council, Inc , New York, to the National Institute for Research in Dairying, in support of researches on cervical mucus, with particular reference to the control of fertility, 1362
- University of Rochester Advances in Semi-Conductor Science—Proceedings of the Third International Conference on Semi-Conductors, 1958 (edited by H Brooks), *review* by Dr J R Tillman, 1674
- University of St Andrews Appointment of Dr D Bijl as reader in natural philosophy at St Salvator's College, 684
  - Appointment of Dr A J O Cruickshank as reader in electrical engineering at Queen's College, 684
  - Appointment of Dr J L Copp as senior lecturer in chemistry at Queen's College, 684
  - Appointment of Dr F D Gunstone as senior lecturer in chemistry at St Salvator's College, 684
  - Appointment of W McNicoll as senior lecturer in civil and mechanical engineering at Queen's College, 684
  - Appointment of Dr A R Mitchell as senior lecturer in mathematics at St Salvator's College, 684
  - Appointment of Dr F Walker as senior lecturer in geology at Queen's College, 684
  - Retirement of Prof E F Freundlich from the directorship of the University Observatory, 768
  - Appointment of Dr D W N Stibbs to the Napier chair of astronomy, 768
- University of Sheffield Appointment of Dr H Kay to the chair of psychology, 93
  - Appointment of Dr S R Elsden to the chair of microbiology, 234
  - Appointment of Dr D E Bourne as lecturer in applied mathematics, 410
  - Appointment of Dr R S Duff as senior lecturer in medicine, 410
  - Appointment of I E Gillespie as lecturer in surgery, 410
  - Appointment of D W Warrell as lecturer in obstetrics and gynaecology, 410
  - Appointment of L Grimshaw as lecturer in psychiatry, 410
  - Appointment of P Chadwick as lecturer in applied mathematics, 684
  - Appointment of Dr J N Murrell as lecturer in chemistry, 684
  - Appointment of C E Blank as lecturer in medical genetics, 684
  - Appointment of Dr J Sykes as lecturer in biochemistry, 684
  - Appointment of Dr J M Hoskins as lecturer in bacteriology and virology, 684
  - Appointment of Dr J Allison and Dr A M Howatson as lecturers in electrical engineering, 684
  - Appointment of K Littlewood as lecturer in fuel technology and chemical engineering, 684
  - Appointment of Dr E W Lee as lecturer in physics, 684
  - Appointment of L Lehman as lecturer in dental mechanics and prosthetics, 684
  - Appointment of T B Ferguson and J D Stringer as lecturers in mechanical engineering, 684
  - Appointment of W J M Tegart and C W Hawarth as lecturers in metallurgy, 684
  - Appointment of Dr J F Wallace as senior Research Fellow in mechanical engineering, 684
  - Title of reader in geography conferred on Dr A Garnett, 684
  - Title of reader in applied mathematics conferred on Dr D R Davies, 684
  - Title of reader in organic chemistry conferred on Dr P L Pauson, 684
  - Appointment of Dr J A Roper to the new chair of genetics, 1189
  - Retirement of Michael Parkin from the Department of Glass Technology, 1271
  - Hatfield Memorial Lecture (Academician G V Kurdjumov), 1450
  - Appointment of E Litton as lecturer in civil engineering, 1451
  - Appointment of L G M Sparling as lecturer in mechanical engineering, 1451
  - Strength of Materials Laboratory in the Department of Mechanical Engineering to be named the F C Lea Laboratory, 1535
  - Research Colloquium on Alkali Ion Determinations by means of Glass Electrodes, 1616
- University of Southampton Appointment of Dr B Thwaites to a third chair of mathematics with special reference to fluid mechanics, 590
  - Appointment of Dr L G A Sims as professor of electrical engineering, 590
  - Title of professor emeritus conferred on Prof P Ford, 595
  - Appointment of R G Woods as deputy librarian, 595
  - Title of senior lecturer in chemistry conferred on Dr G W A Fowles, 595
  - Title of senior lecturer in aeronautical engineering conferred on Dr J P Jones, 595
  - Title of senior lecturer in geography conferred on Dr R A Pelham, 595
  - Appointment of Dr A N Clements as lecturer in physiology and biochemistry, 595
  - Appointment of Dr J Heading as lecturer in applied mathematics, 595
  - Appointment of R W Page as lecturer in mechanical engineering, 595
  - Appointment of Dr J R Rydzewski as lecturer in civil engineering, 595
  - Appointment of Dr R G Scurlock as lecturer in physics, 595
  - Appointment of Dr E V Vernon as lecturer in electronics, 595
  - Appointment of Dr E M Wilson as senior lecturer and director of computation, 1915
  - Appointment of P C Parks as lecturer in aeronautical engineering, 1915
  - Appointment of G G Bloodworth as lecturer in electronics, 1915
  - Appointment of J F Barrett as De Havilland Research Fellow in aeronautical engineering, 1915
  - Appointment of M T Thew as Volkes Research Fellow in mechanical engineering, 1915
- University of Sydney Appointment of C N Watson-Munro to the chair of physics in the field of thermonuclear physics, 1447, 1912
  - Appointment of Dr S T Butler to the chair of physics in the field of theoretical physics, 1447, 1911
  - School of Physics within the 1911
- University of Texas Grant of 1,482,480 dollars from the National Institutes of Health, for basic research in genetics and cell biology, 1108
- University of Texas (Anderson Hospital and Tumour Institute) Fourteenth Annual Symposium on Fundamental Cancer Research (Cell Physiology of Neoplasia), 1451
- University of Toronto New Medical-Surgical Building of the Ontario Veterinary College, 695
- University of Wageningen Conference on Enzymes, 687
- University of Wales Appointment of Dr J R Cross as superintendent o the Chemistry Laboratories in the University College of Swansea, 156
  - Appointment of Glenys Thomas as map curator and cartographer in the Department of Geography in the University College of Swansea, 156
  - Appointment of P W Davies as assistant lecturer in metallurgy at the University College of Swansea, 156
  - Appointment of Dr H E Evans as lecturer in engineering at the University College of Swansea, 156
  - Appointment of B W Preece as assistant lecturer in engineering at the University College of Swansea, 156
  - Retirement of Prof R O Davies from the chair of agricultural chemistry in the University College, Aberystwyth, 317
  - Appointment of Prof T W Goodwin to the chair of agricultural chemistry in the University College, Aberystwyth, 318
  - Appointment of Prof F Llewellyn Jones as acting principal of the University College of Swansea, 410
  - Retirement of Prof Alun Roberts from the chair of agricultural botany in the University College, Bangor, 502
  - Appointment of Dr J L Harper to the chair of agricultural botany in the University College, Bangor, 503
  - Appointment of Dr P T Landsberg to the newly created chair of applied mathematics in University College, Cardiff, 591
- University of Western Australia Appointment of Dr A R Billings as professor of electrical engineering, 93
- University of Witwatersrand Appointment of Dr J P F Sellschop to the chair of nuclear physics, 233
- University College, Aberystwyth Retirement of Prof R O Davies from the chair of agricultural chemistry, 317
  - Appointment of Prof T W Goodwin to the chair of agricultural chemistry, 318
- University College, Bangor Retirement of Prof Alun Roberts from the chair of agricultural botany, 502
  - Appointment of Dr J L Harper to the chair of agricultural botany, 503
- University College, Cardiff Appointment of Dr P T Landsberg to the newly created chair of applied mathematics, 591
- University College, Dublin Appointment of Dr A L Kapoor as an I C I. Fellow in chemistry, 410
- University College of Ghana, Achimota Appointment of Prof F W Sansome as professor of botany, 26
- University College, Ibadan Appointment of Dr E Njoku as professor of botany, 26
- University College, London Title of reader in biochemistry in the University of London conferred on S P Datta, 1273
  - Title of professor of embryology in the University of London conferred on Michael Abercrombie, 1451
  - Title of reader in chemistry in the University of London conferred on Dr D J Millen, 1451
  - Title of reader in botany in the University of London conferred on P J Syrett, 1451
  - Appointment of P R Bell to the University of London readership in botany, 1535
  - Appointment of Dr J B Hasted as reader in physics, 1613
- University College of North Staffordshire A second postgraduate research studentship founded by the U S Rubber Co , 322
  - Appointment of J Penfold and J Beard to the U S Rubber Co 's studentships, 322
  - Postgraduate research studentship founded by the Phillips Petroleum Co , 322
  - Appointment of C J Panton to the Phillips Petroleum Co 's studentship, 322
  - Appointment of Dr D J E Ingram as professor of physics, 410, 590
- University College of Rhodesia and Nyasaland Appointment of W Lloyd Jenkins as lecturer in the Department of Chemistry, with responsibility for teaching agricultural chemistry, 508
- University College of Swansea Appointment of Dr J R Cross as superintendent of the Chemistry Laboratories, 156
  - Appointment of Glenys Thomas as map curator and cartographer in the Department of Geography, 156
  - Appointment of P W Davies as assistant lecturer in metallurgy, 156
  - Appointment of Dr H E Evans as lecturer in engineering, 156
  - Appointment of B W Preece as assistant lecturer in engineering, 156
  - Appointment of Prof F Llewellyn Jones as acting principal, 410
- University College Hospital Medical School, London Appointment of J F Smith as reader in morbid anatomy, 322
- University Co-operation in the Commonwealth (Home Universities Conference 1959), 1613
- University Education in Britain Expansion of, 1431
- University Entrance Requirements Latin in, 297
- University Foundation of Belgium Annual Report for 1957-58, 939
- University Graduates A Career in Education for (Ministry of Education), revised edition, 1777
- University Grants Committee Returns from Universities and Colleges in receipt of Treasury Grant, Academic Year 1957-58, 1118
- University Institute of Chemistry, Lahore, and the Unesco South Asia Science Co-operation Office Regional Training Course for Laboratory Technicians, 857
- University Lectures Visual Illustration of (British Universities Film Council Discussion on), 515
- University Libraries (Home Universities Conference 1959), 1613
- Unknown The Brink of the (Lord Verulam), 1688
- 'Unnatural' Sugars Specific Inhibition of Anti-Rh Serum by (Dr William C Boyd, Marjorie H McMaster and Eugenia Wa[illegible]zenko-Zacharczenko), 989

Unorthodox Primaries Colour-Image Synthesis with Two (Arthur Karp), 710

Unphosphorylated Peptide-Substrates (O-Phosphorylated and), suitable for Tryptic Action (Dr D Theodoropoulos, H Bennich and Prof O Mellander), 270

Unresponsiveness Specific Inhibition of Antibody Formation during Immunological Paralysis and (Dr E Sercarz and Dr A H Coons), 1080

Unresponsiveness (Immunological) Mechanism of (Prof Charles F Crampton, Fred R Frankel and J L Rodeheaver), 873

Unsaponifiable Fraction of Crude Vegetable Oils Chromatographic Identification of the Antilipaemic X Factor of the (Prof M C Nath, A Saikia and B I Uppin), 1635

Unsaturated (Trans-) Acids in the Depot Fat of Ruminants and Non-Ruminants (L Hartman and Dr F B Shorland), 2024

Unsusceptible Cell Lines Infectivity of Polio Virus Ribonucleic Acid for Embryonated Eggs and (P De Somer, Dr A Prinzie and E Schonne), 652

Unusual Alkaline-denaturation Properties A Haemoglobin with, in a Turkish-Cypriot Woman (Dr J E O'N Gillespie, Dr J C White, M J Ellis, Dr G H Beaven, W B Gratzer, Dr E M Shooter and R M E Parkhouse), 1876

Unusual Breeding Habitat of the Linnet (N W Orford), 650

Unusual Diatom from the Antarctic (E J Ferguson Wood), 1962

Up to Date with Chromatography Keeping, *review* by Dr R Consden, 1436

Upper Atmosphere Air Density in the, from Satellite Orbit Observations (Dr G V Groves), 178

Density of the, from Analysis of Satellite Orbits—Further Results (D G King-Hele), 1267

Upper Atmosphere Density Variations due to Hydromagnetic Heating (Dr A J Dessler), 261

Upper Boundary of the Van Allen Radiation Belts (Dr Conway W Snyder), 439

Upper Form Science by the (British Association for the Advancement of Science, Section X (Assembly of Corresponding Societies), Meeting on), 596

Uppin, B I, and others Chromatographic Identification of the Antilipaemic X Factor of the Unsaponifiable Fraction of Crude Vegetable Oils, 1635

Uptake (Cellular), of Deoxyribonucleic Acid by Human Tissue Culture Cells (Dr Stanley M Gartler), 1505

Uptake (Magnesium), from Foliar Applications of its Salts on Apple Role of the Anion in (M Allen), 995

Uptake (Oxygen), of Glycerol-extracted Muscle Fibres (James A Wilson, Paul R Elliott, Prof Karl F Guthe and David G Shappirio), 1947

Uptake and Retention (Mineral), in Cotton-Grass (*Eriophorum vaginatum* L), (Gordon T Goodmand and Donald F Perkins), 467, *erratum* 1845

Uraemia and its Treatment by Arginase Inhibitor (Dhruba K Sen), 459

Uranium as Fuel, 318

Uranium-235 Two Cases of Triple Fission of (J Catala, J Casanova and V Domingo), 1057

Uranium and Thorium Systematic Mineralogy of (Prof Clifford Frondel), *review* by Prof C F Davidson, 576

Uranium and Thorium Alloys Constitutional Diagrams of (Frank A Rough and Arthur A Bauer), *review* by Dr R E D Hughes, 925

Uranus Great Earthquakes and the Astronomical Positions of (Prof A Tomaschek), 177

Urban Expansion Trends in (Prof K C Edwards), B A 43

Urch, Dr D S Appointed lecturer in chemistry at the University of Birmingham, 1915

Urea Promoting Effect of, on the *in vitro* Passive Sensitization of Isolated Plain Muscles with Precipitating Antibody (R Binaghi, Dr B N Halpern, P Liacopoulos and T Neveu), 1805

Urea-Bisulphite Solubility Permanent Set, Supercontraction and—the Proton-Transfer Nature of some Changes in Keratin and the Analogy with Muscle Contraction (Dr P T Speakman), 339

Urea Solutions (Concentrated) Effect of, on the Infectivity and Haemagglutinin of Vaccinia Virus (Prof J F McCrea and Jean O'Loughlin), 1497

Urease Inhibition of, by Alloxan and Alloxanic Acid (Dr Clarke T Gray, Marcus S Brooke and John C Gerhart), 1936

Uredospores (Germinating), of Wheat Stem Rust, Race 15B Biosynthesis of some Amino-Acids from Sucrose by (B Kasting, A J McGinnis and W C Broadfoot), 1943

Urethane as a Carcinogen and as an Anaesthetic for Fishes (Dr J N Ball and Prof P N Cowen), 370

Urethane in Dehydrated and Fasted Mice Subcutaneous Absorption of (Eigill Hvidberg and Jens Schou), 646

Uric Acid Active Transport of, through the Human Erythrocyte Membrane (Dr Kay Overgaard-Hansen and Dr Ulrik V Lassen), 553

Uridine labelled with Tritium Chromosomal Synthesis of Ribonucleic Acid as shown by Incorporation of (G Pelling), 655

Urinary Excretion of β-Amino-*iso*butyric Acid in Mongolism (Dr Thomas L Perry, Dr Kenneth N F Shaw and Dr Dorothy Walker), 1970

Urinary Excretion of some B Vitamins in Man Effect of Sorbitol on the (J D Watson and Prof John Yudkin), 911, *errata*, 1362

Urinary β-Glucuronidase Activity in Patients with Bone Fractures (F J W Lewis and Dr Constance H J Plaice), 1249

Urinary Gonadotrophin Preparation of a Highly Purified Sample of the (Roland Bourrillon, Rene Got and René Marcy), 983

Urinary Histamine in Adrenalectomized Rats Sodium Chloride Intake and (Dr T Bjuro and Dr H Westling), 1241

Urine α-Ketoglutaric Acid and Pyruvic Acid in Blood, Cerebrospinal Fluid and (Dr E Zelnicek), 727

Urine of Pyridoxine-deficient Rats 8-Hydroxyquinaldic Acid, the Red Fluorescent Substance in the (Dr J K Roy, Dr R R Brown and Prof J M Price), 1573

d-Urobilin Optical Activity of Stercobilin and (Prof C H Gray, P M Jones, Dr W Klyne and Dr D C Nicholson), 41

Urokinase-Induced Fibrinolysis of Human Standard Clots (Dr Kuro N von Kaulla), 1320

Urquhart, Dr A R Awarded the Service Medal of the Textile Institute, 156

Use of Atomic Energy The Release and (Dr T E Allibone), 1613

Use of Coated Tubing as Columns for Gas Chromatography (Prof Albert Zlatkis and H R Kaufman), 2010

Use of Coke in Ironmaking Successful (Meeting of the Iron and Steel Institute at the University of Birmingham and at Coalbrookdale to celebrate the 250th anniversary of the), 322

Use of Ground-Based Radar in Meteorology (excluding Upper-Wind Measurements), (World Meteorological Organization, Technical Note No 27), 942

Use of Isotopes in Organic Syntheses, *review* by Dr G Eglinton, 1830

Use of Models in Fire Research (Committee on Fire Research and the Fire Research Conference of the Division of Engineering and Industrial Research of the United States National Academy of Sciences–National Research Council Symposium on), 772

Use of Plant Haemagglutinins (Lectins) A Method for Distinguishing between α- and β-Glycosides by the (Dr O Makela), 111

Use of Porter-Silber and Schiff Reagents as Spot Tests for Steroids applied on Paper and their Application to the Study of Rat Adrenal Lipids (Dr Marion K Birmingham), B A 67

Use of Radioisotopes in Agricultural Research (Ministry of Food and Agriculture of the Government of India, Food and Agriculture Organization of the United Nations, International Atomic Energy Agency and Unesco South East Asia Science Co-operation Office Course on), 1451

Use of the Silicon Resistor in the d c Stabilization of Transistor Circuits (J T Zakrzewski and D H Mehrtens), 811

Use of Solar Energy Transactions of the International Conference on the—The Scientific Basis (Tucson, 1955) , Vol 1, The Available Energy, Measurement of Radiation , Vol 2, Thermal Processes, Part 1, Section A, Flat Plate Collectors , Vol 2, Thermal Processes, Part 1, Section B, High-Temperature Solar Furnaces, Solar Power , Vol 3, Thermal Processes Part 2, Solar House Heating, Solar Water Heating, Solar Stoves, Solar Distillation , Vol 4, Photochemical Processes , Vol 5, Electrical Processes, *review* by Dr H Heywood, 217

Use of Transparent Cellulose Film for Roller Tube Tissue Cultures (John A Sharp), 1508

Use of Tritium to Study the Solubility of Water in Hydrocarbons (B D Caddock and P L Davies), 2011

Use (Combined), of Polymyxin and Acetone to obtain Cell-free Enzymes (J R Villanueva), 1565

Use (Efficient), of Man-power in Industry (Report of an inquiry by the National Joint Advisory Council), 25

Use (Excess) Enhanced Synaptic Function due to (Dr Rosamond M Eccles and Dr R A Westerman), 460

Use (Histochemical), of the Cyanocarbon Organic Compounds (Prof John F Lhotka), 1153

Use (Practical), of the Microscope (George Herbert Needham), *review* by Dr S Bradbury, 1174

Use (Water-) Survey Water-Resources and (Dr Alice Garnett), 96, *erratum*, 684

Usmanov, S R Macromolecules (Physics of Polymers), 1689

U S S R British Association for the Advancement of Science to send two representatives (Dr W E Swinton and Sir George Allen) to the, 1271

Higher Education in the, 504

Pharmaceutical Research in the, *review* by Dr D Train, 1831

Technical and Vocational Education in the (M I Movšovič), 504

Tectonics in the, 942

Uterine Wall of the Pig during the Sexual Cycle Periodic Acid-Schiff-Positive Material and Alkaline Phosphatase in the (Rolv Austad and Dr Otto Garm), 999

Uterus (Isolated Rat) Some Pharmacological Effects of Staphylolysin on the (Dr B Wiegershausen), 2017

Utilizzazione del Suolo, Carta della Sheets 19 and 20, Calabria (Ferdinando Milone) , Sheets 21, 22 and 23, Sicily (Ferdinano Milone), (Consiglio Nazionale della Ricerche, Napoli), 27

Uvarov Dr B P *Obituary* of Prof F S Bodenheimer, 937

Uwents, H Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Work on Cobalt), 691

Uyeda, S (Nagata, T , and) Exchange Interaction as a Cause of Reverse Thermo-Remanent Magnetism, 890

VACANCIES and other Point Defects in Metals and Alloys—a Symposium organized by the Institute of Metals, 1957 (Monograph and Report Series, No 23), *review* by Dr F C Thompson, 1765

Vaccinia Virus Effect of Concentrated Urea Solutions on the Infectivity and Haemagglutinin of (Prof J F McCrea and Jean O'Loughlin), 1497

Vaccinia Virus Inactivated by Mercury Reactivation of (Colin Kaplan), 1074

Vaccinia or Ectromelia Virus Transformations of Myxoma into, in Tissue Culture (Hidesaburô Hanafusa, Teruko Hanafusa and Juntarô Kamahora), 1152

Vacek, Dr A Increased Oxygen Consumption in Rats during Irradiation, 197

Vacuum Metallurgy—Lectures presented during the Course sponsored by the Department of Metallurgical Engineering in co-operation with the Office of Special Service to Business and Industry, New York University, 1957, *review* by Dr F C Thompson, 1765

Vacuum Science and Technology, Joint British Committee for Formation of a, 1191

Vagal Afferents in the Monkey (Prof Kent M Chapman and Prof James W Pearce), 1237

Vaidya, M S (Poe A J and) A Radiochemical Tracer Study of the Relative Stability of the Halogenoplatinates, 1139

Vaidyanathan, C S , and Street Prof H E A Non-Dialysable Inhibitor of Glutamo-Transferase present in Excised Tomato Roots, 347

Nitrate Reduction by Aqueous Extracts of Excised Tomato Roots, 531

Vaidyanathan, C S (Sukanya, N K , and) Biochemical Research in India (Purification and Properties of a Naturally Occurring Inhibitor of Glutamine Synthesis present in *Pongamia* Galls), 1368

Valadon, F (Germain, J E, and) Coal Science (Chemical Reactions of Coal—Chromatographic Separation of Oxidation Products of Coal), 413

Valatin, Dr J G Title of reader in mathematical physics in the University of Birmingham conferred on, 1362, 1688

Valentine, Dr L International Symposium on Macromolecules, Wiesbaden, 1689

Valentine, Dr R C The Shape of Protein Molecules suggested by Electron Microscopy, 1838

D-Valine Inhibition of Actinomycin Synthesis by (Prof Edward Katz), 1666

Vallaeys, G, et autres Recherches sur l'Autostérilite du Caféier robusta (*Coffea canephora* Pierre), 518

Vallee, Dr B L (Wacker, Dr W E C, and) Chromium Ribonucleoprotein from Bovine Liver, 1399

Vallois, Prof H V At the Muséum National d'Histoire Naturelle's celebration of the anniversaries of the 'Precurseurs et Fondateurs de l'Evolutionnisme—Buffon, Lamarck, Darwin', 860

Value of π and the Old Testament (Dr J Heading), 78

Value of Contour Analysis in Equatorial Meteorology (D H Johnson and Dr H T Morth), 1372

Value of a Simple Observational Technique for Determining the Fat Content of Algal Cells (Dr J H Evans), 1737

Values The Measurement of (Prof L L Thurstone), *review* by Prof Ll Wynn Jones, 1010

Vamathevan, P, and others Swellings on the Shoots of Cacao Plants Deficient in Copper, 75

Vamos, R, and Vida, L Antibacterial Substances of Coniferous Seedlings at Different Stages of their Development, 915

Van Allen, J A, and others (C F H Allen, in collaboration with) Six-Membered Heterocyclic Nitrogen Compounds with Three Condensed Rings, *review* by Dr F G Mann, 216

Van Allen, Prof James A, and Frank, Louis A Radiation Measurements to 658,000 km with *Pioneer IV*, 219

Van Allen Radiation Belts The Upper Boundary of the (Dr Conway W Snyder), 439

van Atta, Dr C M Thermonuclear Processes (Survey of the American programme), 241

Van Bavinchove, J, and others Influence of X-Rays on the Activity of Carbonic Anhydrase in Erythrocytes and on their Haemolytic Resistance, 111

van Bekkum, D W Biological Effects of Low Doses of Ionizing Radiations (Chemical Protection against Biological Effects of Ionizing Radiation) 1112

van Beneden, Pierre Joseph (1809-94), 1913

van Cakenberghe, J (Offergeld, G, and) Stoichiometry of Bismuth Telluride and related Compounds, 185

Van Dijk, — Thermodynamics (Physical Constants), 1608

van Drimmelen, Prof G C Bacteriophage Typing applied to Strains of *Brucella* Organisms, 1079

Van Dyke, Donald C, and others Lack of Direct Effect of Erythropoietin on Human Erythroid Cells *in vitro*, 1228

van Dyke, Prof H B, and others Active Principles of the Neurohypophysis of Cold-blooded Vertebrates—Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates, 1464

Van Fleet, D S Histological Localization of Peroxidase, 506

Van Gelder, R G A Taxonomic Revision of the Spotted Skunks of the Genus *Spilogale*, 1024

van Gool, Dr W, and van Santen, Dr J G Special Ceramics (Polycrystalline Aggregate of Cadmium Sulphide as an Element in Photosensitive Devices), 1116

van Haaften, J L Œstrogens in Pasture, 1575

van Heyningen, Dr Ruth Formation of Polyols by the Lens of the Rat with 'Sugar Cataract, 194

van Horn, Elizabeth, and Ware, Dr G C Growth of *Bacterium coli* and *Staphylococcus albus* in Heavy Water, 833

van Krevelen, Prof D W, and others Coal Science (Carbonization—Strength of Coke in relation to Particle Size of Coal Carbonized), 413, (Carbonization—Carbonization of Synthetic Polymers containing Aromatic Units linked by Methylene Bridges labelled with Radioactive Carbon), 413

van Krevelen, Prof D W (Smidt, J, and) Coal Science (Spectroscopy of Coals—Electron Magnetic Resonance Spectroscopy to study Coals in course of Carbonization under Vacuum), 413
  Number of Free Radicals in Coal during Carbonization at Different Heating Rates, 719

Van Loon, E J, and others Effect of Ethylenediamine Tetra-acetate on Vitamin B_{12} Absorption in the Rat, 1948

van Overbeek, Dr J Plant Growth Regulation (Relation between Structure and Auxin Activity), 600

van Santen, Dr J G (van Gool, Dr W, and) Special Ceramics (Polycrystalline Aggregate of Cadmium Sulphide as an Element in Photosensitive Devices), 1116

van Steenis, C G G J (compiled by) Vegetation Map of Malaysia, including New Guinea (Unesco), 27

Van Valkenburgh, Nooger and Neville, Inc Basic Electricity—a Course of Training developed for the United States Navy, adapted to British and Commonwealth Usage by a special Electronics Training Investigation Team of the Royal Electrical and Mechanical Engineers, *review* by G R Noakes, 133

Van Wambeke, A, et autres Carte des Sols et de la Vegetation du Congo Belge et du Ruanda-Urundi, 6, Yangambi, Planchette 3, Lilanda, A, Sols, B, Vegetation (Institut National pour l'Etude Agronomique du Congo Belge), 27

Van Wazer, John R Phosphorus and its Compounds, Vol I, Chemistry, *review* by Dr F G Mann, 389

van Weel, Dr A Awarded the Sir Louis Sterling Premium of the British Institution of Radio Engineers, 857

van Wieringen, J S, and Kats, A Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158

van Wijk, Prof W R Soil Salinity Course in Tunisia, 1778

van Wijngaarden, Adriaan Awarded a Silver Medal of the City of Paris, B A 16

van den Heuvel, A P, and Mason, Dr B J Habit of Ice Crystals grown in Hydrogen, Carbon Dioxide and Air at Reduced Pressure, 519

van der Kerk, Prof G J M *Obituary* of Prof F Kogl, 1609

Van der Pijl, L Origin and Dispersal of Flowering Plants (Angiosperm Flower must have differentiated in Contact with Beetles), 1200

van der Pol, Dr B *Obituary* by Dr R L Smith-Rose, 1020

Van der Ziel, Prof A Fluctuating Properties in Semi-Conductors, *review* by Dr R A Hyman, 1754

Vanadium Treatment Intracellular Thioctic Acid and Coenzyme A following (E Mascitelli-Coriandoli and Dr C Citterio), 1641

Vancomycin Selective Inhibition of Ribonucleic Acid Synthesis in *Staphyloccus aureus* by (Prof D C Jordan and W E Inniss), 1894

Vand, Prof Vladimir Formation of Stellar Associations from Galactic Gas, 441

Vandepitte, Dr J, and others Haemoglobin *P* in a Family in the Belgian Congo, 1133

Vanderbilt University Abraham Flexner Lectures, 1958 (Sir Macfarlane Burnet), *review* by Dr J H Humphrey, 753

Vanguard Solar Effects in the Motion of (Dr Stanley P Wyatt), 351

Vanek, Z, and others An Electron-Microscopic Study of Spores of Morphological Variants of *Streptomyces erythreus* Strains, 1888

Vãnngard, Tore, and Åkerstrom, Stig Electron Spin Resonance and Divalency of some Dithiocarbamates of the Coinage Metals (Cu, Ag, Au), 183

Vapour-Liquid Equilibrium (Eduard Hala, Jiři Pick, Vojtech Fried and Otakar Vilim), translated by G Standart, *review* by Dr R Sargent, 837

Vapour-Liquid Equilibrium Treatise, *review* by Dr R Sargent, 837

Vargas, J I (Maddock, Dr A G, and) Influence of Crystal Defects on the Szilard-Chalmers Process in Solids, 1931

Variant (A 40-Chromosome), in *Solanum nigrum* L (U K Rai), 1587

Variants (Foetal), in Singapore Heterogeneity of Human Foetal Haemoglobin—Incidence of (Dr F Vella), 272

Variants (Morphological), of *Streptomyces erythreus* Strains An Electron-Microscopic Study of Spores of (L Dolezilova, Z Vanek and O Kralik), 1888

Variants (Transferrin) Haptoglobin and, in Bushmen and some other South African Peoples (Dr N A Barnicot, J P Garlick, Ronald Singer and Dr J S Weiner), 2042

Variation Virus Growth and—Ninth Symposium of the Society for General Microbiology, London, 1959 (edited by A Isaacs and B W Lacey), *review* by N W Pirie, 920

Variation in Lizards of the *Leiocephalus cubensis* Complex in Cuba and the Isla de Pinos (Albert Schwartz), 1107

Variation (Diurnal), of Aurora and Geomagnetic Disturbance at New Zealand Antarctic Stations (Dr T Hatherton and G G Midwinter), 889

Variation (Temperature), of the Principal Magnetic Moments of Co^{++} Ions and the Asymmetry of the Crystalline Electric Field in Cobalt Acetate Tetrahydrate (Dr Bhagawati Charan Guha), 50

Variations in Early Cleavage of the Zebra Fish (A W Marrable), 1160

Variations in the Supply of Potassium, Calcium and Magnesium Effect on the Groundnut of (Dr R Comber), 1003

Variations (Oxygen Isotope), in Antarctic Snow Samples (Dr R Gonfiantini and Prof E Picciotto), 1557

Variations (Upper Atmosphere Density), due to Hydromagnetic Heating (Dr A J Dessler), 261

Variety Trials (Agricultural) Influence of Site and Season on (A Sandison), 834

Varley, Prof G C Evolution of Host–Parasite Relationships (Host Specificity), 763
  Animal Clocks, 764
  A Controversial Equation in Population Ecology, 1583

Vascular Beds Resistance to Flow in (Harris S Burry), 453

Vascular Plants Comparative Morphology of (Adriance S Foster and Ernest M Gifford, Jr), *review* by Dr S Williams, 84

Vasicinone (A Bronchodilator Alkaloid), from *Adhatoda vasica* Nees (A H Amin and D R Mehta), 1317

Vasopressin Gel Filtration as a Method for Purification of Protein-bound Peptides as exemplified by Oxytocin and (E B Lindner, Dr A Elmqvist and Dr J Porath), 1565
  Mechanism of the Antidiuretic Effect of (Dr Tsutomu Kashiwagi), 991

Vasopressin and Oxytocin Specific and Sensitive Assay Method for, using Glass-Paper Chromatography (Akira Arimura and Prof Joseph F Dingman), 1874

Vasotocin Arginine (Active Principles for the Neurohypophysis of Cold-blooded Vertebrates), (Panayotis G Katsoyannis and Prof Vincent du Vigneaud), 1465

Vasotocin (Arginine), and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates Pharmacological Evidence for the Presence of (Active Principles for the Neurohypophysis of Cold-blooded Vertebrates), (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464

Vaughan, D J (Langford, W J, and) Separation of Polyvinyl Chloride and Polyvinyl Acetate by Chromatographic Methods, 116

Vaughan, F Clay Minerals (Dehydration Products of Kaolinite), 780

Vaurie, Dr Charles The Birds of the Palearctic Fauna—Order Passeriformes, *review* by Sir Landsborough Thomson, 666

Vaux, R Nuclear Reactors for Power Generation, *review*, 301

Večeřikova, V (Kessler, M F, and) Coal Science (Physical and Physicochemical Measurements on Cokes) 414

Vegetable Oils (Crude) Chromatographic Identification of the Antilipaemic X Factor of the Unsaponifiable Fraction of (Prof M C Nath, A Saikia and B I Uppin), 1635

Vegetable Research Station, National New Laboratory Building (J A Nelder), 1368

Vegetable Tannins The Chemistry of—Being the Papers presented at a Symposium held in the University, Cambridge, 1956, under the auspices of the Society of Leather Trades' Chemists), *review* by Dr A I Scott, 1832

Vegetation Mapping (International Society for Plant Geography and Ecology International Symposium on), B A 23

Vegetation du Congo Belge et du Ruanda-Urundi Carte des Sols et de la —6, Yangambi, Planchette 3, Lilanda, A, Sols, B, Vegetation (Notice explicative par P Gilson, P Jongen, A Van Wambeke et L Liben), (Institut National pour l'Étude Agronomique du Congo Belge), 27

Vegetation on Mars (W M Sinton), 1612

Vegetation Map of Africa (Explanatory notes by R W J Keay, with a French translation by A Aubreville), 594

Vegetation Map of Malaysia, including New Guinea (compiled by C G G J van Steenis), (Unesco), 27

Vegetative Period Redox Potentials in Soybean Nodul[illegible] during the (Dr Helena Ebertova), 1046

Vein Anastomoses in the Leaves of Long Shoots of *Ginkgo biloba* (Dr Howard J Arnott), 1336
Velardo, Prof Joseph Thomas (edited by) The Endocrinology of Reproduction, *review* by Dr T Mann, 1434
  Essentials of Human Reproduction, *review* by Dr T Mann, 1434
Vella, Dr F Heterogeneity of Human Foetal Haemoglobin—Incidence of Foetal Variants in Singapore, 272
Vellela and *Physalia* Dimorphism and Size Distribution in (Prof Robert Bieri), 1333
Velocity of Slow-Drift Solar Radio Bursts Geomagnetic Disturbance and (M B Wood and C S Warwick), 1471
Velocity of Sound in Relaxing Gases (H J Wintle), 2007
Velocity Patterns (Blood) Intravascular and Intracardiac, recorded by means of *NTC* Resistors (Dr W G Zijlstra, J R Brunsting and L B v d Slikke), 991
Venables, Dr P F R Sandwich Courses for Teaching Technologists and Technicians, *review*, 1437
Venom (Cottonmouth Moccasin), labelled with Iodine-131 Distribution in the Mouse of Lethal and Sub-Lethal Doses of (Prof J F Gennaro, jun , and H W Ramsey), 1244
Venous Anastomosis Establishment of Parenchymatous Spleno-Pulmonary (Dr George R Walker, Dr Paul Field and Dr Patrick E Conen), 703
Ventilation Heating and (British Occupational Hygiene Society Conference on), 1987
Ventricle Preparation (Rat) Potentiation of Contractions after Rest in the Isolated (Dr R L Speirs), 66
Venus Radio Echo Observations of (J V Evans and G N Taylor), 1358
Verco Medal of the Royal Society of South Australia awarded to Dr C G Stephens, 1611
Verdier, M , and others Maternal Control of Ovariole Number in the Progeny of the Migratory Locust, 103
Vereš, K , and others Influence of DL-beta-Phenylserine on the Synthesis of Proteins in *Escherichia coli*, 1895
Verlicchi, L , and others N-Substituted 7-Methoxy-8-Aminoethylchromones and Flavones—New Brain-Stem Stimulants, 362
Vermeil Medal of the City of Paris awarded to Prof Howard H Aiken, B A 16
Vermiculite Diffusion of Exchangeable Cations in (G F Walker), 1392
Vernadsky Institute, Moscow Current Geochemical work being carried out at the (Prof A P Vinogradov), 1193
Vernon, Dr E V Appointed lecturer in electronics at the University of Southampton, 595
Vernon, K C Soil and Land-Use Surveys of the Regional Research Centre of the British Caribbean, No I, Parish of St Catherine, Jamaica, 27
Vernon Prof Magdalen D Perception, Attention and Consciousness (Presidential Address to Section J (Psychology) of the British Association for the Advancement of Science), B A 45
Vernon Prize for 1960 (National Institute of Industrial Psychology), 1450
Verschuren, Jacques Exploration du Parc National de la Garamba, Mission H de Saeger, Fasc 9, Écologie et Biologie des Grands Mammifères (Primates, Carnivores, Ongulés), 155
Vertebrates Germfree—Present Status (James A Reyniers and 30 other authors), 1541
  Natriferin, a New Hormonal Principle in the Neurohypophysis of certain (J Maetz, F Morel and B Lahlouh), 1236
  Regeneration in (edited by Charles S Thornton), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Neth, 839
Vertebrates (Cold-blooded) Active Principles of the Neurohypophysis of—Chromatographic and Biological Characteristics of Fish and Frog Neurohypophysial Extracts (B T Pickering and Prof H Heller), 1463 , Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from Cold-blooded Vertebrates (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464 , Arginine Vasotocin (Panayotis G Katsoyannis and Prof Vincent du Vigneaud), 1465
  Pharmacological Evidence for the Presence of Arginine Vasotocin and Oxytocin in Neurohypophysial Extracts from (Active Principles for the Neurohypophysis of Cold-blooded Vertebrates), (Wilbur H Sawyer, Robert A Munsick and Prof H B van Dyke), 1464
Vertical Intensity (Geomagnetic), around the Magnetic Equator Possible Asymmetry in the Daily Range of the (Dr C A Onwumechilli), 51
Verulam, Lord The Brink of the Unknown (Annual Lecture of the Plastics Institute), 1688
Very Cold World, *review* by Prof J F Allen, 1260
Very High Frequency Radio Signals at Ionospheric Heights Refraction of (S Weisbrod and L Colin), 119
Very High Reynolds Number A Spectrum of Turbulence at (H L Grant, A Moilliet and Prof R W Stewart), 808
Very Low Frequency Phenomena at Godhavn, Greenland Observations of 'Whistlers' and (Eigil Ungstrup), 806
Very Low-Frequency Spectra of Atmospherics propagated through the Ionosphere (Tatsuzo Obayashi), 34
Vesicle (Seminal) Influence of Sexual Stimulation on the Metabolic Activity of Deoxyribonucleic Acid in the (Dr S R Pelc), 1414
Veterinary Association, World Establishment of a, 853
  Election of Prof W I B Beveridge as president of the Permanent Committee, 853
Veterinary College (Ontario) New Medical-Surgical Building of the, 695
Veterinary Congress The International (Dr M A Soltys), 598
Veterinary Education World Meeting on (Food and Agriculture Organization of the United Nations), 943
Veterinary Medical Association (Canadian) Eleventh Annual Convention, 695
Vibration New Techniques in the Analysis of Noise and (Acoustics Group of the Physical Society and the Institute of Physics Symposium on), 415
  Mechanical Impedance Methods in, *review* by Prof R E D Bishop, 1764
Vibrational Relaxation and Dissociation of Carbon Dioxide behind Shock Waves (Dr I R Hurle and Dr A G Gaydon), 1858
Vibrations (Mechanical) Mechanical Impedance Methods for—Colloquium presented at the Annual Meeting of the American Society of Mechanical Engineers, 1958 (edited by R Plunkett), *review* by Prof R E D Bishop, 17[illegible]
Vibrations (Rigid-Body and Internal), of Organic Molecules An X-Ray Study of (Dame Kathleen Lonsdale and Dr H Judith Milledge), 1545
Vibrations (Ultrasonic), at 10,000 Megacycles (Dr E H Jacobsen), *erratum*, 27
Vibrio metchnikovi treated with Antibody and Complement Release of Compounds containing Diaminopimelic Acid from (Dr F Shafa and Dr M R J Salton), 1341
Vicia faba L Glyceric Acid in Broad Bean (R I Morrison and Dr P C Dekock), 819
Vicia villosa Influence of Gibberellic Acid and Photoperiod on the Growth, Flowering, Nodulation and Nitrogen Assimilation of (the late Prof Margaretha G Mes), 2035
Vickers, M D (Thomas, Dr J O , and) Conversion of Ionospheric Virtual Height-Frequency Curves to Electron Density-Height Profiles (Radio Research Board, Special Report No 28), 1024
Vickery, Dr R C Synthesis of Boron Phosphide and Nitride, 268
Victoria, Australia *Sporidesmium bakeri* recorded from (B S Janes), 1327
Victorian Period Free Trade in Land in the (O R McGregor), 1916
Vida, L (Vamos, R , and) Antibacterial Substances of Coniferous Seedlings at Different Stages of their Development, 915
Vida na Lunda Flagrantes da (Introducao de Dr Jose Osorio de Oliveira), (Companhia de Diamantes de Angola, Museu fo Dundo, Publicacoes Culturais No 37), 236
View (Russian), of Space Flight, *review* by D G King-Hele, 836
Vilar, O , and others Histological Localization of Fluorescent Thyroid-stimulating Hormone in Rat Tissues, 1733
Vilim, Otakar, and others Vapour–Liquid Equilibrium (translated by G Standart), *review* by Dr R Sargent, 837
Villanueva, J R Interference by Azide with Diazotization Procedures used in Biological Assay Systems, 549
  Combined Use of Polymyxin and Acetone to obtain Cell-free Enzymes, 1565
Villela, Dr Gilberto G (Bacila, Metry, and) A Rapid and Sensitive Method for the Determination of Xanthine Oxidase Activity using the Oxygen Electrode, 1394
Vince, Dr D Elected honorary secretary of the Photobiology Group, 1362
Vincent, Prof J Distribution of Sodium in Compact Bone, as revealed by Autoradiography of Neutron-activated Sections, 1332
Vines, H M (Wedding, R T , and) Inhibition of Reduced Diphosphopyridine Nucleotide Oxidation by Ammonia, 1226
Vinogradov, Prof A P Current Geochemical Work being carried out at the Vernadsky Institute, Moscow, 1193
Vinyl Polymerizations initiated by γ-Rays A Capacitance Method for following (G J K Acres and F L Dalton), 335
Vioque, E , and others Quantitative Estimation of the Fatty Acids o Olive Oil, 1941
Viral Multiplication and Cellular Hyperplasia (Prof Councilman Morgan), 435
Virology Perspectives in—a Symposium (edited by Morris Pollard), *review* by N W Pirie, 920
Virtual Height-Frequency Curves Conversion of Ionospheric, to Electron Density-Height Profiles (Dr J O Thomas and M D Vickers), (Radio Research Board, Special Report No 28), 1024
Virulent Clones of *Fusarium oxysporum* f *cubense* A Rapid and Simple Pathogenicity Test for Detecting, using Seedlings of *Musa balbisiana* (Dr R H Stover), 1591
Virus Transmission of a, to Strawberry Plants by a Nematode (*Xiphinema* sp), (Asharfi Jha and Dr A F Posnette), 962, *erratum*, 1192
Virus of Foot-and-Mouth Disease Effect of Proflavine on the Formation of the, and its Infective Ribonucleic Acid in Pig Kidney Tissue Culture Monolayers (F Brown and Doreen L Stewart), B A 74
Virus (Arabis Mosaic) Role of a Dagger Nematode (*Xiphinema* sp) in Outbreaks of Plant Diseases caused by (Dr B D Harrison and Dr C H Cadman), 1624
Virus (Canine Distemper), in Tissue Culture An Attenuated Strain of (Prof Gunnar Rockborn), 822
Virus (Ectromelia) Transformations of Myxoma into Vaccinia or, in Tissue Culture (Hidesaburô Hanafusa, Teruko Hanafusa and Juntarô Kamahora), 1152
Virus (Herpes Simplex) Purification of, by Chromatography of Calcium Phosphate (Janice Taverne and Peter Wildy), 1655
Virus (Influenza) Serum Inhibitors of Asian Strains of (Suzanne M James and Paul Fiset), 1656
Virus (New Maize) Needle Transmission of a (Dr I Harpaz), B A 77
Virus (Parotid Tumour) (Polyoma Virus) Antibody Status of Mice and Response of their Litters to (Lloyd W Law, Clyde J Dawe, Wallace P Rowe and Janet W Hartley), 1420
Virus (Plant-) Inhibitor from Rice Chemical Nature of a (W A Jones, M Jacobson and R P Kahn), 1146
Virus (Polio) Ribonucleic Acid Infectivity of, for Embryonated Eggs and Unsusceptible Cell Lines (P De Somer, Dr A Prinzie and E Schonne), 652
Virus (Poliomyelitis) Appearance of Crystalline Needles in Monkey Kidney Cell Cultures infected with, and Incubated at 22°-30° C (Dr Esther Tenenbaum), 1657
Virus (Polyoma) (Parotid Tumour Virus) Antibody Status of Mice and Response of their Litters to (Lloyd W Law, Clyde J Dawe, Wallace P Rowe and Janet W Hartley), 1420
Virus (Rabbit-pox) Antiviral Chemotherapeutic Activity of Isatin β-thiosemicarbazone in Mice infected with (D J Bauer and F W Sheffield), 1496
Virus (Tick-borne Encephalitis) Infectious Ribonucleic Acid from Mouse Brains infected with (F Sokol, H Libikova and J Zemla), 1581
Virus (Tobacco Mosaic) Effect of Nitrous Acid on—Mutation or Selection ? (F C Bawden), B A 27
  Replication of—Kinetics of Virus Protein and Ribonucleic Acid Biosynthesis (Prof Barry Commoner, Dr James A Lippincott and Dr Janey Symington), 1992 , a Re-examination of Theories (Prof Barry Commoner), 1998
  Rotational Friction Coefficients of Models of, and the Size of the Virus Particle (Dr A J Haltner and Dr B H Zimm), 265
Virus (Tobacco Mosaic), inactivated by Antibody Recovery of Infectious Nucleic Acid from (Dr Irving Rappaport) , 1732
Virus (Vaccinia) Effect of Concentrated Urea Solutions on the Infectivity and Haemagglutinin of (Prof J F McCrea and Jean O'Loughlin), 1497

Virus (Vaccinia), Inactivated by Mercury Reactivation of (Colin Kaplan), 1074
Virus (West Nile) Duration of Protective Action of Interferon against Infection with (Dr Alick Isaacs and Marguerite A Westwood), 1232
Virus Disease of *Meloidogyne incognita incognita*, the Southern Root Knot Nematode (J R Loewenberg, T Sullivan and M L Schuster), 1896
Virus Disease (A Suspected), of the Citrus Red Mite (*Panonychus citri* (McG), (Dr Kenneth M Smith, G J Hills, F Munger and J E Gilmore), 70
Virus Growth and Variation—Ninth Symposium of the Society for General Microbiology, London, 1959 (edited by A Isaacs and B W Lacey), *review* by N W Pirie, 920
Virus-infected Plant Tissues Biochemical Mechanism of Lesion Formation in (Dr F Solymosy, Dr G L Farkas and Dr Z Kiraly), 706
Virus Multiplication Isolation of Tobacco Leaf Cells capable of supporting (Prof Milton Zaitlin), 1002
Virus Nucleoprotein Particles (Turnip Yellow Mosaic), with Differing Biological and Physical Properties (R E F Matthews), 530
Virus Particle Rotational Friction Coefficients of Models of Tobacco Mosaic Virus and the Size of the (Dr A J Haltner and Dr B H Zimm), 265
Virus Protein Kinetics of, and Ribonucletic Acid Biosynthesis (Replication of Tobacco Mosaic Virus), (Prof Barry Commoner, Dr James A Lippincott and Dr Janey Symington), 1992
Virus Research Advances in (edited by Dr Kenneth M Smith and Max A Lauffer), Vol 6, *review* by N W Pirie, 920
Viruses Recent Work on the Electron Microscopy of (Dr Kenneth M Smith), 1440
Viruses (Animal) Inactivation of some, by Hydroxylamine and the Structure of Ribonucleic Acid (Dr Richard M Franklin and Dr Eberhard Wecker), 343
Viscoelasticity A Molecular Approach to the Problem of (Prof Alfred H Nissan and H G Higgins), 1477
Viscosity (Effective) Sedimentation and (Prof G J Kynch), 1311
Visible Absorption Spectra of Copper-ethylene-diamine-*bis* (acetylacetone) in the Crystalline State (Animesh Chakravorty and Dr Sadhan Basu), 50
Vision (Spatial Detail) Measurements of Temporal Adaptation to (A, J Seyler and Z L Budrikis), 1215
Vistas in Astronautics—First Annual Air Force Office of Scientific Research Astronautics Symposium (edited by Morton Alperin and Marvin Stern), *review* by D G King-Hele, 663
Visual Cortex of the Unanaesthetized Cat Evoked Potentials in (Gabriel Horn and John Blundell), 173
Visual Illustration of University Lectures (British Universities Film Council Discussion on), 515
Visual Pigments of some Common Laboratory Mammals (Dr C D B Bridges), 1727
Visual Space Possible Role of Higher Proprioceptive Centres in the Perception of, and in the Control of Motor Behaviour (Dr B Gurevitch), 1219
Visual Spatial and Temporal Summation (Dr Ernest Baumgardt), 1951
Visualization of Acid and Alkaline Phosphatase after Starch-Gel Electrophoresis of Seminal Plasma, Serum and Bile (Dr Bengt Estbörn), 1636
Visualization of Magnetic Processes (Prof L F Bates), B A 41
Vitamealo Fellowship of the Animal Health Trust awarded to D B Ross, 771
Vitamin A in Fish Liver Oils Isomers of (Patricia S Brown, William P Blum and Max H Stern), 1377
Vitamin A Storage in the White Rat Effect of 'Amino-Acid Imbalance' on Growth and (M Rechcigl, jun , S Berger, J K Loosli and H H Williams), 1404
Vitamin B_{12} New Antimetabolites from (G H Timmis and Dr S S Epstein), 1383
Vitamin B_{12} Absorption in the Rat Effect of Ethylenediamine Tetraacetate on (Edward G Rice, Dr Samuel M Greenberg, John F Herndon and E J Van Loon), 1948
Vitamin B_{12} Content of Ewes' Milk Effect of Cobaltic Oxide Pellets on the (L I Hart and E D Andrews), 1242
Vitamin C Estimation of, by Agar Diffusion (Alan H Chaiet and Louis Chaiet), 1487
Vitamin D Effect of, on the Respiration of Rat Oral Tissue (L Zar and Prof J T Irving), 1410
Vitamin E Curative Effect of Selenium upon the Incisor Teeth of Rats deficient in (Prof J T Irving), 645
An Effect of Selenium and Cystine on Lipide Peroxidation in Tissues Deficient in (Dr John G Bieri), 1148
Ubiquinone and (Dr Thomas Moore), 607
Vitamin K An Antimetabolic Action of (Prof E Quagliariello, C Saccone, E Rinaldi and M R Alioto), 820
Vitamins (Indian Institute of Science Symposium on), 1367
B Vitamins in Man Effect of Sorbitol on the Urinary Excretion of some (J D Watson and Prof John Yudkin), 911, *errata*, 1362
Vitousek, Dr M J (Mason, Dr R G , and) Some Geomagnetic Phenomena associated with Nuclear Explosions, B A 52
Vivants (Etres) Causes de la Répartition des (Raymond Furon), *review* by Prof Ronald Good, 390
Viviparous Deep-Sea Jellyfish (Dr F S Russell), 1527
Vivipary in *Eleusine indica* (L) Gaertn (H T Clifford), 1888
Vlassov, Dr N Nuclear Forces and the Few-Nucleon Problem (Binding Energies and Elastic Scattering of Light Nuclei at Low Energies), 1114
Vlitos, Dr A J The Central Agricultural Research Station, Carapichaima, Trinidad, 331
Vlitos, Dr A J , and Crosby, Dr D G Isolation of Fatty Alcohols with Plant-Growth Promoting Activity from Maryland Mammoth Tobacco, 462
Vocational Education (Technical and), in the U S S R (M I Movšovič), 504
Vogt, G S (George, II , L A , and) Electron Microscopy of Autoradiographed Radioactive Particles, 1474
Vogt, Dr Marthe Biosynthesis and Secretion of Adrenocortical Steroids, 417
Curare and Curare-like Agents, *review*, 1093
Acetophenetidin, *review*, 1349
Voipio, Dr A Polar Front Survey (Hydrography—Chemistry of the Barents Sea Water), 1181
Voisin, André Grass Productivity (translated from the French by Catherine T M Herriot), *review* by Dr W Davies, 1675
Volatile Compounds on Gas–Liquid Chromatography Columns Unexpected Formation of (C Weurman and J Dhont), 1480
Volatile Fatty Acid Relationship between *p*H and, and Diversion of Saliva from the Actively Fermenting Rumen of Sheep (W R McManus), 1572
Volatile Liquid Partition Chromatography (Dr Roger S Porter and Dr Julian F Johnson), 978
Volatile Methoxides of Aluminium and Zirconium (Dr D C Bradley and Dr M M Faktor), 55
Volcanic Activity on the Moon (N A Kozyrev), 856
Volcanic Rocks (Cenozoic), in New Zealand Palaeomagnetic Studies of (Dr D S Coombs and Dr T Hatherton), 883
Volcanoes on the Moon (Dr Maurice W Windsor), 1556
Volf, Dr V Attempts to Modify the Normal Metabolism of Strontium-90 in Rats, 1401
Volger, Dr H C Awarded a Netherlands Fellowship in Chemistry for 1959-60 by the Ramsay Memorial Fellowships Trustees, B A 16
Voltage (High-) Paper Electrophoresis of Aliphatic Amines and related Compounds (Dr D Gross), 1633
Voltage (High-) Paper Electrophoresis (Two-Dimensional), of Amino- and other Organic Acids (Dr D Gross), 1298
Voltage (Low-) Arcs Emission of Relatively High-Energy Ions from (E R Harrison), 245
Voltmeter A New Multi-range, 'Taylormeter Model 100*A*' (Taylor Electrical Instruments, Ltd), 1026
Volume (Number and), of the Islets of Langerhans in Different Size Classes in Non-diabetic Humans of Varying Ages Actual Distribution of the (Bo Hellman), 1498
Volume (Target) of Enzyme Induction X-Ray Sensitivity and (Dr Helmut Pauly), 1570
von Bertalanffy, Dr Ludwig The Road to Knowledge (Role of Theoretical Biology in Integrative Sciences), B A 7
von Engel, A Thermonuclear Research (Shock Waves in Gases), 1017
von Euw, J , and others 3,4,ω-Trihydroxyacetophenone 3-methyl Ether in Adrenal Extracts, 268
von Karman, Dr Chemistry of Propellants, 779
Basic Problems in Propulsion, 779
von Kaulla, Dr Kuro N Urokinase-Induced Fibrinolysis of Human Standard Clots, 1320
von Magnus, Dr Preben, and others Statement on Biological and Chemical Warfare, 1018
von Mises, Richard Mathematical Theory of Compressible Fluid Flow (completed by Hilda Geiringer and G S S Ludford), *review* by Dr W P Jones, 485

WACKER, Dr W E C , and Vallee, Dr B L Chromium Ribonucleoprotein from Bovine Liver, 1399
Waddington, Dr C J Photography in the International Geophysical Year (Study of the 'Footprints' of Cosmic Ray Particles), 1032
Appointed lecturer in physics at the University of Bristol, 1613
Wadso, I Thermodynamics (Experimental Thermochemistry), 1607
Wagner, W Thermodynamics (Experimental Thermochemistry), 1607
Waid, J S Availability of Plant Nutrients (Probable Parts played by Micro-organisms), 160
Wain, Prof R L Plant Growth Substances, *review*, 925
Wain, Prof R L , and others Plant Growth Regulation (Metabolism of Indole Auxins in Plants), 599
Occurrence of 3-Indolylacetic and 3-Indolecarboxylic Acids in Tomato Crown-Gall Tissue Extracts, 825
Wain, Prof R L (Taylor, H F , and) α-Oxidation of Indoleacetonitrile, 1142
Waismann, F Turning Points in Physics (The Decline and Fall of Casuality), *review* by G R Noakes, 1090
Wakelam, J A , and Jaffe, W P Unidentified Chick Growth Factors, 272
Wakelam, J A and others Unidentified Growth Factors, 271
Wakonig, R , and others Chromosome Complement of Spontaneous Leukaemia in *AKR* Mice, 998
Waksmundzki, Andrzej, and Soczewinski, Edward A Paper-Chromatographic Method for the Determination of Suitable Buffer Systems for Countercurrent Distribution, 977
Wald, Prof George Photochemical and Stereochemical Properties of Carotenoids at Low Temperatures—Discussion, 620
Wald, Prof George, and others Photochemical and Stereochemical Properties of Carotenoids at Low Temperatures—*Cis-trans* Isomerism and Steric Hindrance, 617
Waldhauer, Fred D , and others Transistor Electronics, *review* by J W R Griffiths 838
Waldmann-Meyer, H Paper Electrophoretic Patterns obtained by Paraffin-Oil Fixation, 1567
Wales (England and) Marital Fertility in (Prof E Grebenik), 1035
Ninety-fifth Report (1958) of the Chief Inspector on Alkali, etc , Works in, 940
Statistical Review of, for the Year 1957, Part 2, Tables, Civil (Registrar General), 1107
Walford, Dr Lionel A Living Resources of the Sea, *review* by Dr F S Russell, 129
Walker, Dr Dorothy, and others Urinary Excretion of β-Amino-isobutyric Acid in Mongolism, 1970
Walker, Dr D G , and Bowman, Dr J E Glutathione Stability of the Erythrocytes in Iranians, 1325
Walker, Dr D J Blood Acetylcholinesterase in *Phalaris* Staggers, 1411
Walker, Dr F Appointed senior lecturer in geology at Queen's College, Dundee, 684
Walker, G F Diffusion of Exchangeable Cations in Vermiculite, 1392
Walker, Dr George R , and others Establishment of Parenchymatous Spleno-Pulmonary Venous Anastomosis, 703
Walker, Dr J Nuclear Technology and the Scholarly Tradition, *review*, 1973
Walker, Dr P M B Awarded a grant of £5,900 by the Paul Instrument Fund Committee of the Royal Society, 507
Walker, Prof R Milnes Appointed a member of the Medical Research Council, 772

Walker, Prof T K Obituary of Dr Maurice Copisarow, 315
Walkinshaw W Promoted to Deputy Chief Scientific Officer in the Scientific Civil Service, 859 , work of, 859
Wall, Dr C G Appointed lecturer in chemical engineering at the University of Birmingham, 1915
Wall, E T (Davies, Dr D Roy, and) Separation of Gamma-Irradiation of Two Elements at the Vby Locus in *Trifolium repens*, 1957
Wall, Victor From Man Power to Atomic Power (Christmas Lecture at the Science Museum, London), 1535
  The Story of Flight (Christmas Lecture at the Science Museum, London), 1535
Wall of the Gastro-intestinal Tract of the Infant Rat Passage of Insulin through the (Dr B Mosinger, Z Placer and O Koldovsky), 1245
Wall of Small Blood Vessels in Human Multiform Gliobastoma Electron Microscopical Structure of the (Dr S H M Nystrom), 65
Wallpaintings (English) The Conservation of—being a Report of a Committee set up by the Central Council for the Care of Churches and the Society for the Protection of Ancient Buildings, 1119
Wallace, Dr F J Appointed lecturer in mechanical engineering at the University of Birmingham, 684
  Appointed senior lecturer in mechanical engineering at Queen's University, Belfast, 1613
Wallace, Dr J F Appointed senior Research Fellow in mechanical engineering at the University of Sheffield, 684
Wallace, Dr John H , and others Maintenance of Parathyroid Tissue Fragments on Agar Substrates, 1734
Wallace, W E Thermodynamics (Phase Changes in Condensed Systems), 1609
Waller, Prof R D After Work—Leisure and Learning in Two Towns, 1034
Wallgren, Henrik Sex Difference in Ethanol Tolerance of Rats, 726
Wallis, Dr F S Retirement from the directorship of the Bristol City Museums, 1685 , work of, 1685
Walls of *Bacillus subtilis* Structure of Teichoic Acid from the (Teichoic Acids from Bacterial Walls), (J J Armstrong, Prof J Baddiley and Dr J G Buchanan), 248
Walls (Bacterial) Composition of Teichoic Acids from a Number of (Teichoic Acids from Bacterial Walls), (J J Armstrong, Prof J Baddiley; Dr J G Buchanan, A L Davison, M V Kelemen and F C Neuhaus), 247
  Teichoic Acids from—Composition of Teichoic Acids from a Number of Bacterial Walls (J J Armstrong, Prof J Baddiley, Dr J G Buchanan, A L Davison, M V Kelemen and F C Neuhaus), 247 , Structure of Teichoic Acid from the Walls of *Bacillus subtilis* (J J Armstrong, Prof J Baddiley and Dr J G Buchanan), 248
Walmsley, V G , and others A Revised Classification of the Ludlovian Succession at Ludlow, 1037
Walsh, A At the Second Australian Spectroscopy Conference (Present Status of Emission and Atomic Absorption Spectroscopy), 1197
Walsh, A (Gatehouse, Dr B M , and) At the Second Australian Spectroscopy Conference (Direct Analysis of Metals and Alloys), 1197
Walsh, Dr J R , and others At the Second Australian Spectroscopy Conference (Polarized Visible Spectrum of Single Crystals of Phthalocyanine), 1196
Walsh, Dr J W T First award of the Gold Medal of the Illuminating Engineering Society made to, 1106 , work of, 1106
Walsh, Dr R J (Clark, Peggy, and) Synthesis of Haem by Circulating Blood Cells, 1730
Walsh, Dr T Appointed director of An Foras Taluntais (The Agricultural Institute), Dublin, 29 , work of, 29
Walter, Harry, and others Enzymes and Radioactivity in Erythrocytes of Different Ages, 643
Walter, N M , and others Liquid Crystal Systems from Fibrillar Polysaccharides, 632
Walther, Alwin Awarded a Silver Medal of the City of Paris, B A 16
Walton, G N (edited by) Glove Boxes and Shielded Cells for Handling Radioactive Materials—a Record of the Symposium on Glove Box Design and Operation held in the Cockcroft Hall, A E R E , Harwell, 1957, *review*, 1599
Walton, W H Heating and Ventilation, 1987
Wandless, A M, and Fenton, G W Coal Science (Carbonization—Coking Tests on Coals of 84, 85 and 87 per cent Carbon Content), 413
Wang, Dr Hao Formalization of Constructive Concepts, *review*, 1435
Wang, Shih Yi Ultra-violet Irradiation of 1,3-Dimethylthymine, B A 59
  Photoautomerization of Cytosine Derivatives on Ultra-violet Irradiation, 184
Wansbrough-Jones, Sir Owen Resignation as chief scientist to the Minister of Supply, B A 13 , work of, B A 13
War (World), II , Surgery in, Neurosurgery, Vol I (Colonel John Boyd Coates, editor-in-chief), *review* by J E A O'Connell, 1676
Warburg, Dr E F , and others Excursion Flora of the British Isles, *review* by P Falk, 1093
Warburg's Equation Application of, to Tissue Slices (Dr I S Longmuir and Dr Ann Bourke), 634
Warcup, J H Isolation of Basidiomycetes from the Soil, 506
Ward, Alan G The British Gelatine and Glue Research Association, 862
Ward, A L , and Reddan, M J Ionization Phenomena in Gases (Way in which Space Charge influences the Current Growth to give the observed Voltage-Current Density Characteristics), 1354
Ward, Prof S G Crushing and Grinding, *review*, 1177
  Second Symposium on Coal Preparation, *review*, 1601
Ward, Prof S G (Lawson, G J , and) Coal Science (Chemical Reactions of Coal—Chromatographic Separation of Oxidation Products of Coal), 413
Wardlaw, Prof C W Coconuts, *review*, 1760
Wardrop, A B Cell-Wall Formation in Root Hairs, 996
Wardrop, I D , and others Cause of Wear in Sheeps' Teeth, 1583
Ware, A A Thermonuclear Research, 1015
Ware, Dr G C (Van Horn, Elizabeth, and) Growth of *Bacterium coli* and *Staphylococcus albus* in Heavy Water, 833
Wareing, Prof P F (Longman, Dr K A , and) Early Induction of Flowering in Birch Seedlings, 2037
Warfare (Biological and Chemical) Pugwash International Conference of Scientists—Statement on, 1018
Warhurst Alan Appointed director of the Bristol City Museums, 1686 , work of 1686
Warner Medal of the Textile Institute awarded to Dr Margaret Hannah, 26
Warrell, D W Appointed lecturer in obstetrics and gynaecology at the University of Sheffield, 410
Warren, G W Electron Bombardment Floating-zone Melting and Allied Electron Bombardment Techniques (Out-gassing of Molybdenum in the Solid State), 692
Warren, Prof Harry V Geology and Multiple Sclerosis, 561
Warren, R G , and Benzian, B High Levels of Phosphorus and Die-Back in Yellow Lupins, 1588
Warren Spring Laboratory, Stevenage (Department of Scientific and Industrial Research), 146
Warwick, C S (Wood, M B , and) Geomagnetic Disturbance and Velocity of Slow-Drift Solar Radio Bursts, 1471
Warwick, Dr G P (Roberts, Dr J J , and) Metabolic and Chemical Studies of 'Myleran'—Formation of 3-Hydroxytetrahydrothiophene-1,1-dioxide *in vivo*, and Reactions with Thiols *in vitro* 1288
Warwick, Kenneth (Beloff, Dr John and) Chance and Probability (Wishful Seeing in a Gambling Situation), 497
Warwicker, J O Biological Fibres B A 25
Waste (Radioactive) Disposal of (K Saddington and W L Templeton), *review*, 301
Waste Treatment (Trade) River Pollution Sewage Disposal and (Department of Civil Engineering and the Department of Extra-Mural Studies in the University of Birmingham Course on), 1451
Wasczenko-Zacharczenko, Eugenia, and others Specific Inhibition of Anti-Rh Serum by 'Unnatural' Sugars, 989
Watanabe, Ryoji, and Koda, Shigeyasu Reversion of Nodules formed by the Grain Boundary Reaction in Aluminium–Zinc Alloys, 977
Watanabe, Tadashi (Odaka, Prof Takeshi, and) Transformation Reaction of Pneumococci in the Absence of Serum Factor, 471
Watelle-Marion, G Thermodynamics (Spectrophotometric Study of the Ionization of a Divalent-Metal Salt), 1609
Water An Embedding Resin Miscible with, for Electron Microscopy (Dr I R Gibbons), 375
  Carbon Dioxide in, in Wine, in Beer and in other Beverages (F Justin Miller), *review* by Dr A H Cook, 302
  The Growing Demand for (First Report of the Subcommittee of the Central Advisory Water Committee), B A 18
  Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in for Occupational Exposure (United States National Bureau of Standards, Handbook 69), 939
Water in Hydrocarbons Use of Tritium to Study the Solubility of (B D Caddock and P L Davies), 2011
Water and Woodlands (International Association of Scientific Hydrology, Publication No 48), 1184
Water (Distilled) 'Deminrolit' Plants for (Permutit Co , Ltd), 25
Water (Ennerdale) Relict Fauna of—a Problem of Distribution (Dr W Pennington), 1421
Water (Heavy) Growth of *Bacterium coli* and *Staphylococcus albus* in (Elizabeth van Horn and Dr G C Ware), 833
  Saliva-Serum Ratios of Deuterium Oxide after Administration of (Nan Taggart and Dr F E Hytten), 457
Water (Rain-) Potassium/Sodium Ratio in (B C V Oddie), 1791
Water (Rain), collected in the Humid Central Congo Basin Nitrogen Content of (J Meyer and E Pampfer), 717
Water (Surface-) Resources Techniques for Surveying (Prof Ray K Linsley), (World Meteorological Organization, Technical Note No 26), 96, *erratum*, 684
Water Bugs (Land and), of the British Isles (Dr T E R Southwood and Dennis Leston), *review* by W J Le Quesne, 1977
Water Committee, Central Advisory First Report of the Subcommittee on the Growing Demand for Water, B A 18
  Report of the Subcommittee on Information on Water Resources, B A 18
  Re-appointments and new appointments, 153
Water Content (High and Low) Free Radicals in X-Rayed Seeds of, as Measured by Electron Spin Resonance (Dr W Klingmuller, Dr G R Lane, M C Saxena and Dr D J E Ingram), 464
Water Droplets Supercooling of (P G Fox), 546
Water Fungi *Blastocladiella* and *Allomyces* Gamma Particles, Nadi-Positive Mitochondria, and Development in the (Prof Edward C Cantino and Gilbert Turian), 1889
Water Hyacinth (*Eichornia crassipes*) Effects of the, in the Nile Valley (H R J Davies), 1085
Water-Melon (*Citrullus vulgaris*) α-Amino-β-(pyrazolyl-N) Propionic Acid, a New Amino-Acid from (Dr F F Noe and Dr L Fowden), B A 69
Water Pollution Research 1958—the Report of the Water Pollution Research Board with the Report of the Director of the Water Pollution Research Laboratory (Department of Scientific and Industrial Research), 1542
Water Pollution Research Board Report for 1958, with the Report of the Director of the Water Pollution Research Laboratory (Department of Scientific and Industrial Research), 1542
Water Pollution Research Laboratory Open Days, B A 17
Water Resources Effects of Forest Areas on, and the Technique of Lysimetry—Water and Woodlands (Dr L Leyton), 1184 , Lysimeters (F W Green), 1186
  Information on (Report of the Subcommittee of the Central Advisory Water Committee), B A 18
Water-Resources and Water-Use Survey (Dr Alice Garnett), 96, *erratum*, 684
Water Supply and Demand in Great Britain (Prof W G V Balchin), B A 18
Water-Use Survey Water-Resources and (Dr Alice Garnett), 96, *erratum*, 684
Water Vapour Pressure World Distribution of Atmospheric (G A Tunnell), B A 15
Water-borne Preservatives Limitations Imposed by some, on the Soil Block Test Method for Timber (A J McQuire), 1430
Waterbury, W E (Macdonald, Prof R E and) Colorimetric Estimation of Citric Acid, 988
Waterlow, Dr John Effect of Protein Depletion on the Distribution of Protein Synthesis, 1875

Waterman, Dr A T Research and Development and Economic Growth (United States National Science Foundation, Reviews of Data on Research and Development No 13), 591
Waterman, H I, and others Coal Science (Carbonization—Carbonization of Synthetic Polymers containing Aromatic Units linked by Methylene Bridges labelled with Radioactive Carbon), 415
Waters, R T Ionization Phenomena in Gases (Sparks in Long Gaps), 1355
Waters, Dr W A Oxidation of Organic Compounds (Relationship between Vanadate and Permanganate Oxidations), 326
Waters, Dr W A (Littler, Dr S, and) Oxidation of Organic Compounds (Pentavalent Vanadium an Oxidiser in Acid Solution), 327
Waters (British East African) Black Marlin in (F Williams), B A 78
Waters (Coastal), of Japan (1959) Concentration of Caesium-137 in the (Noboru Yamagata) 1813
Waters (Navigable) Oil in (P Barclay-Smith), 949
Waterton, P J Appointed Staff Fellow in physics in the University of Birmingham, 1915
Waterways (Inland), in Britain, 1687
Waterways and Ionizing Radiations, 1450
Watson, D K, and others The Inner Solar Corona during June 1959, 1308
Watson, Prof E C Appointed scientific attaché to the United States Embassy in India, 1686, work of, 1686
Watson, J D, and Yudkin, Prof John Effect of Sorbitol on the Urinary Excretion of some B Vitamins in Man, 911, *errata*, 1362
Watson, J P, and others Soil and Land-Use Surveys of the Regional Research Centre of the British Caribbean, No 3, St Vincent, 27
Watson, P Keith (Sharbaugh, A Harry, and) Conduction Currents in Liquid *n*-Hexane under Microsecond Pulse Conditions, 2006
Watson, W A (Beverley, Dr J K A, and) Ovine Abortion due to Toxoplasmosis, 2041
Watson, the late W C R Handbook of the Rubi of Great Britain and Ireland, *review* by R D Meikle, 489
Watson, W F Macromolecules (Mechanochemical Reactions of Polymers), 1690
Watson-Munro, C N Appointed to the chair of physics in the field of thermo-nuclear physics in the University of Sydney, 1447, work of, 1447
Watson-Watt, Sir Robert, and others Statement on Biological and Chemical Warfare, 1018
Wave Reflexion (Direct Continuous-) Apparent Observation of Solar Corpuscular Clouds by (Dr John D Klaus and W Reed Crone), 965
Waves (Shock) Vibrational Relaxation and Dissociation of Carbon Dioxide behind (Dr I R Hurle and Dr A G Gaydon), 1858
Waves (Ultrasonic), in Liquids Propagation of (Prof A K Dutta, M Subudhi and K Samal), 352
Wax Fraction (Paraffin), from Tobacco Leaf and Tobacco Smoke Composition of a (Dr W Carruthers and Dr R A W Johnstone), 1131
Way Things Are The (Prof P W Bridgman), *review* by Prof C K Grant, 1975
Wayman, P A A Least-Squares Solution for a Linear Relation between Two Observed Quantities, 77
Wax Secretion of, through the Cuticle of Insects (Dr M Locke), 1967
Weale, Dr R A, and others Fusion Frequency and Light Quantity, 1873
Weapon Tests (Nuclear), and the Accident at Windscale Accumulation of Radioactive Iodine in Thyroid Glands subsequent to (Dr Hamish A Robertson and Ian R Falconer), 1699
Weapons Debris (Nuclear) Fractionation Phenomena in (K Edvarson, Kerstin Low and J Sisefsky), 1771
Wear in Sheeps' Teeth Cause of (Dr G Baker, Dr L H P Jones and I D Wardrop), 1583
Wear Observations through Interfacial Micro-Windows (Robert H Savage), 45
Weatherall, Prof M Humane Experiments, *review*, 1675
Weatherley, Dr P E (Peel, A J, and) Composition of Sieve-Tube Sap, 1955
Weaver, Dr Warren Retirement as vice-president for the natural and medical sciences of the Rockefeller Foundation, 23
  Appointed vice-president of the Alfred P Sloan Foundation, 23
Webb, Dr Edwin C Enzymes (Properties of the various Coenzymes, Prosthetic Groups and Activators of Enzymes), 687
  Steric Aspects of the Chemistry and Biochemistry of Natural Products (Stereospecificity in Enzyme Action—Hydrolytic Enzymes), 948
  Enzymes, *review*, 1759
Webb, Dr Edwin C (Dixon, Dr Malcolm, and) Non-Inverted versus Inverted Plots in Enzyme Kinetics, 1298
Webb, R F New Research and Production Facilities of Ciba (A R L), Ltd, 601
Webber, Dr J M, and others Action of Manganese Dioxide on Simple Carbohydrates, 1301
Weber, Dr G, and Teale, F J W Energy Transfer with special reference to Biological Systems (Energy Transfer in the Haem Proteins), 689
Weber, Dr G (Porter, Prof G, and) Energy Transfer with special reference to Biological Systems, 688
Weber, Miroslawa, and others Thiosulphate Metabolism in the Animal Organism, 994
Weber, W A Origin and Dispersal of Flowering Plants (Southern Survival of many Arctic and Sub-arctic Species), 1200
Webster, Dr George C (Breitman, Dr Theodore R, and) Monovalent Cations and the Incorporation of Metabolites by Isolated Thymus Nuclei, 637
Webster, R A Awarded a Stothert Research Fellowship by the Royal Society, 595
Wecker, Dr Eberhard The Structure of Science (Viral Nucleic Acids), B A 9
Wecker, Dr Eberhard (Franklin, Dr Richard M, and) Inactivation of some Animal Viruses by Hydroxylamine and the Structure of Ribonucleic Acid, 343
Weclewska, M Coal Science (Ultra-fine Structure of Coals and Chars—Influence of Sorption on Coals of Organic Vapours on their Elasticity), 413
Wedding, R T, and Vines, H M Inhibition of Reduced Diphosphopyridine Nucleotide Oxidation by Ammonia, 1226
Wedin Kjell (Lindahl, Prof Per Eric, and) Registration of the Spermicidal Effects of Dioctyl Sodium Sulphosuccinate, 1289
Weed Transportation New Zealand Research on, 1361
Weeds (Foreign) Introduction of, into New Zealand (A J Healy), 1361
Weeping Bearings Sponge-hydrostatic and (Mechanism of Animal Joints), (Dr C W McCutchen), 1284
Weeping Lubrication in Mammalian Joints Experimental Evidence for (Mechanism of Animal Joints), (P R Lewis and Dr C W McCutchen), 1285
Weevils of France, *review* by R T Thompson, 573
Wehlau, Prof W (Brannen, Dr E, and) Polarization and Resolving Time Effects In Photon Correlation, 263
Weibull, Prof C, and others Affinity of Lysozyme to Structural Elements of the Bacterial Cell as studied with Enzyme Labelled with Radioactive Iodine, 1744
Weidemann, Dr H Polar Front Survey (Hydrography—Work with Towed Electrodes (*GEK*) between Greenland and Iceland), 1182
Weigel, Dr H, and others Interaction of Sucrose Stearate with Starch, 110
  Interaction of Anti-Staling Agents with Starch, 547
Weight of Internal Fat, 'Fill', and the Herbage Intake of Grazing Cattle A Relationship between (J C Tayler), 2021
Weinberg, Alvin M, and Wigner, Eugene P The Physical Theory of Neutron Chain Reactors, *review* by Dr J Walker, 1973
Weiner, Dr J S, and others Haptoglobin and Transferrin Variants in Bushmen and some other South African Peoples, 2042
Weiner, Prof Murray Lability of Fibrinolysin, 1937
Weinreich, Gabriel Heads-Tails Statistics for Two Partially Distinguishable Coins, 1825
Weinstein, L H, and others Plant Growth Regulation (Isolation of a New Acid from Coconut Milk), 600
Weintroub, S The Physical Society (1958-59), 419
  The Design of Physics Research Laboratories, *review*, 925
  The Physical Society, 954
Weipers, W L At the Eleventh Annual Convention of the Canadian Veterinary Medical Association (Developments in Veterinary Education), 696
Weisbrod, S, and Colin, L Refraction of Very High Frequency Radio Signals at Ionospheric Heights, 119
Weiss, Dr L Decrease in Radiosensitivity of the Intact Mouse Spleen produced by Hypoxia, 1156
Weissenberg, Prof K Flow Properties of Biological Systems (Rheological Phenomena likely to make their appearance in Biological Systems), 1540
Weissler, G L Ionization Phenomena in Gases (Techniques used to Study the Interaction of the Vacuum Ultra-violet Photons ($h\nu$=7 to 30 eV) with Gases), 1354
Weizmann Memorial Lecture Fifth (Sir Christopher Ingold), *review* by Dr R I Reed, 1262
Weld Structure Discontinuity Crack Behaviour at a (F J Radd), 543
Welded Structures Fatigue of (British Welding Research Association and the Engineering Department of the University of Cambridge Symposium on), 1915
Welding The Electric Arc in (Third 'Joining of Metals' Conference at the University of Birmingham), 1030
Welding Research Association, British, and the Engineering Department of the University of Cambridge Symposium on the Fatigue of Welded Structures, 1915
Welford, A T Ergonomics, its Place in Industry, B A 21
Wellcome Fellowships of the Animal Health Trust awarded to P H Lamont and I R Falconer, 771
Wellcome Trust Grant of £40,000 to the Chester Beatty Research Institute, B A 15
  Second Report (1956-58), 505
Weller, Dr A Energy Transfer with special reference to Biological Systems (Reactions of Excited Singlet State Molecules), 689
  Fast Chemical Reactions in Solution (Fluorescence Method to measure the Fast Reactions of Excited Molecules), 1453
Weller, F H, and others Transformation of a Cubic Boron Nitride to a Graphitic Form of Hexagonal Boron Nitride, 715
Wells, A K Outline of Historical Geology, fourth edition, *review*, 1093
Wells, E J (Ross, Dr I G, and) At the Second Australian Spectroscopy Conference (Studies on the Tetrahedral Molecules OsO_4 and RuO_4), 1195
Wells, M Awarded a Senior Studentship by the Royal Commission for the Exhibition of 1851, 409
Welsby, Dr V E G, and others Awarded the Brabazon Premium of the British Institution of Radio Engineers, 857
Welsh, Prof J H Hormones in Crustaceans, *review*, 1761
Welsh Soils Discussion Group Discussion on Mineralogical Aspects of Soil Science, 156
Welte, Prof E, and Mechsner, Kl Biological Action of Potassium-40 in Naturally Occurring Potash Salts, 1958
Wender, I (Ergun, S, and) Coal Science (X-ray Scattering of Vitrinites reduced with Lithium in Ethylene Diamine), 412
Wenk, Prof E Alpine Mineral Fissures, 1909
Wenkeova, Dr J, and Pav, Dr J Release of Non-Esterified Fatty Acids from Adipose Tissue in Normal and Diabetic Rats, 1147
Went, Dr Arthur E J The Salmon, *review*, 577
Wentrof, jun, Dr R H, and others Preparation of Diamond, 1094
Werner, Dr A E A Chemistry in the Preservation of Antiquities, 585
Werret, W F, and others Semi-Albino, a Third Sex-linked Allelomorph of Silver and Gold in the Fowl, 480
Wersäll, J (Lowenstein, Prof O, and) A Functional Interpretation of the Electron-Microscopic Structure of the Sensory Hairs in the Cristae of the Elasmobranch *Raja clavata* in Terms of Directional Sensitivity, 1807
Wescott, E M (Hessler, V P, and) Correlation between Earth-Current and Geomagnetic Disturbance, 627
Wesson, J A Ionization Phenomena in Gases (Effect of Runaway Electrons on the Heating of a Plasma), 1356
West, C A Plant Growth Regulation (Gibberellin-like Substances in Higher Plants), 600
West, Frank Mellor Library of the British Ceramic Research Association opened by, 153
West, Dr G B, and others Insulin and Hypersensitivity, 2020
West Wisdom of the (Bertrand Russell), edited by Paul Foulkes, *review* by Gerd Buchdahl, 1829

West Africa Capsicum Species of (C Oyolu), 1163
West Nile Virus Duration of Protective Action of Interferon against Infection with (Dr Alick Isaacs and Marguerite A Westwood), 1232
Westerman, M P, and others Activation and Inhibition of the Arylesterase of Human Serum, 430
Westerman, Dr R A (Eccles, Dr Rosamond M, and) Enhanced Synaptic Function due to Excess Use, 460
Western, Prof J H Appointed to the chair of agricultural botany in the University of Leeds, 405, work of, 405
Rothamsted Experimental Station—Report for 1958, 781
Western Nigeria Stone Implements from (E L Kostick, C N Williams and S A Williams), 124
Western Technology A History of (Friedrich Klemm), translated from the German by Dorothea Waley Singer, *review* by K R Gilbert, 1601
Western Thought The History of, *review* by Gerd Buchdahl 1829
Westheimer, Prof F H Oxidation of Organic Compounds (Oxidation of Alcohols), 326
Westheimer, Prof F H, and Chang, Y E Oxidation of Organic Compounds (Oxidation of Pinacol and its Monomethyl Ether), 326
Westlake, D F Water Pollution Research 1958, 1542
Westling, Dr H (Bjuro, Dr T, and) Sodium Chloride Intake and Urinary Histamine in Adrenalectomized Rats, 1241
Westrum, E F Thermodynamics (Phase Changes in Condensed Systems), 1609
Westwood, Marguerite A (Isaacs, Dr Alick, and) Duration of Protective Action of Interferon against Infection with West Nile Virus, 1232
Wet Conditions (Dry and) Effect of X-Radiation on the Survival of Yeast in (A Mookerjee), 1502
Wetherill (John Price) Medals of the Franklin Institute awarded to Dr A J P Martin, Dr R L M Synge and Dr A T James, 857
Wettstein, Dr A, and others 3,4,ω-Trihydroxyacetophenone 3-methyl Ether in Adrenal Extracts, 268
Weurman, C, and Dhont, J Unexpected Formation of Volatile Compounds on Gas-Liquid Chromatography Columns, 1480
Wharton, R H Age Determination in *Mansonioides* Mosquitoes 830
What is Mathematics ?—New Answers to an Old Question (Prof M H A Newman), 32
What are our Schools For ? (Sir James J Robertson), B A 47
Wheat (Germinating) Isolation and Purification of Nitrate Reductase from Embryos of (D Spencer), 682
Wheat Embryos (Pea and) Fine Structure in Cells of (G Setterfield, H Stern and F B Johnston), 505
Wheat Stem Rust, Race 15B Biosynthesis of some Amino-Acids from Sucrose by Germinating Uredospores of (B Kasting, A J McGinnis and W C Broadfoot), 1943
Wheaten Flour Extraction of the Total Protein from in the Form of Soluble Derivatives (E E McDermott and Dr J Pace) 546
Whelan, Dr W J Appointed meetings secretary of the Biochemical Society, 1192
Whewell, Prof C S The Chemistry of Clothing, 849
Whichaway Nunataks, Antarctica Palaeomagnetism of some Dolerite Intrusions from the Theron Mountains and (D J Blundell and P J Stephenson), 1860
Whiffen, Dr D H Energy Transfer with special reference to Biological Systems, 689
Macromolecules (Applications to Polymer Studies of Electron Spin Resonance), 1690
Whipp, E Appointed G E C Hirst Fellow in the Department of Electrical Engineering, University of Birmingham, 684
Whistler Medium Telluric Origin of the (Dr Francis S Johnson), 1787
'Whistlers' and Very Low Frequency Phenomena at Godhavn, Greenland Observations of (Eigil Ungstrup), 806
White, D Thermodynamics (*o-p* and Isotope Separations by Preferential Adsorption at Low Temperatures), 1609
White, D, and others Separation of the *Meta-* and *Para-*Isomers of the Xylenes, Cresols and Toluidines by Gas Solid Chromatography, 1796
White, Dr F W G Appointed chairman of the Commonwealth Scientific and Industrial Research Organization, Australia, 317, work of, 317
White, Dr F W G, and Gill, D A *Obituary* of Sir Ian Clunies-Ross, 230
White, Guy Kendall Experimental Techniques in Low-Temperature Physics, *review* by Prof J F Allen 1260
White, G L At the Second Australian Spectroscopy Conference (Application of Polynomials fitted with 'Least Squares' Methods for the Calibration of Infra-red Spectrometers), 1197
White, Prof J Clay Minerals, 779
White, Dr J C, and Elmes, Dr P Flow Properties of Biological Systems (Viscosity, Intrinsic Viscosity and Thixotropy Measurements on Dilute Bronchial Mucoid Sputum), 1540
White, Dr J C, and others A Haemoglobin with Unusual Alkaline-denaturation Properties in a Turkish-Cypriot Woman, 1876
White, J W Awarded an Overseas Scholarship by the Royal Commission for the Exhibition of 1851, 409
White, J W, and others At the Second Australian Spectroscopy Conference (Polarized Visible Spectrum of Single Crystals of Phthalocyanine), 1196
White, R B, and others Radiation Observations with Satellite 1958δ over Australia, 391
White Blood Cells of Rats (WR Strain) A Sex Difference in (Dr Hans Meier), 1082
White Paper on Higher Education in East Africa, 243
White Rat Effect of 'Amino-Acid Imbalance' on Growth and Vitamin A Storage in the (M Rechcigl, jun, S Berger, J K Loosli and H H Williams), 1404
White and Colored Lights and Darkness Behavior and Reactions of the Pacific Sardine, *Sardinops caerulea* (Girard) under the Influence of (Dr A S Loukashkin and Dr N Grant), 865
Whitear, Brian Awarded a Perkin Centenary Fellowship, 237
Whitehead, G B Pyrethrum Resistance conferred by Resistance to DDT in the Blue Tick, 378
Whitehead, Peter J Feeding Mechanism of *Tilapia nigra*, 1509
Whiting, Dr G C, and Carr, Dr J G Metabolism of Cinnamic Acid and Hydroxy-Cinnamic Acids by *Lactobacillus pastorianus* var *quinicus*, 1427
Whitley, Gilbert, and Allan, Joyce The Sea-Horse and its Relatives, *review* by T H [illegible]wkins, 390
Whitmore, Dr R L Flow Properties of Biological Systems (Differential Flow Velocities of Plasma and Corpuscles in the Living Body), 1540
Whitmore, Dr T C (Bate-Smith, Dr E C, and) Chemistry and Taxonomy in the Dipterocarpaceae, 795
Whitney, N J, and Mortimore, C G Isolation of the Antifungal Substance 6-Methoxybenzoxazolinone, from Field Corn (*Zea mays* L) in Canada, 1320
Whittaker, D Ionization Phenomena in Gases (Decay of Interrupted Arcs), 1355
Whittaker, J R Localization of Haemocyanin on Starch Gel Electrophoretic Patterns, 193
Whittaker, Dr V P Promoted to Senior Principal Scientific Officer in the Scientific Civil Service, 859, work of, 859
Whole-Body γ-Irradiation Cells which Synthesize Deoxyribonucleic Acid in Guinea Pig Bone Marrow during Recovery from (P F Harris and J H Kugler), 1883
Whole-Body X-Irradiation Effect of, on the Insulin Resistance of Fasted Rats (Dr V Stanković and N Sestan), 1816
Metabolic Changes induced in Mammalian Erythrocytes by (Prof D A Rappoport and B W Sewell), 846
Whole Hypothalamic Extract Effects of Methylthiouracil or Thyroidectomy on Activation of Pituitary Acid Phosphatases *in vitro* by (Dr V Schreiber and Dr V Kmentova), 728
Whole Insects Sectioning Large Heavily Sclerotized (Prof W E Beckel), 1584
Whyman, B H F Gas Chromatography (Simple Apparatus for Drawing Long Lengths of Coiled Glass Capillary), 328
Wiberg Prof K B Oxidation of Organic Compounds (Oxidation of Diphenylmethane), 326
Wiborg Dr K F Polar Front Survey (Biology—Distribution of Zooplankton in the Norwegian Sea), 1183
Wickstead, J H, and Bone, Quentin Ecology of Acraniate Larvae, 1849
Wide-range Grating Spectrometers Resolution of (Dr A E Martin), 975
Wiegershausen, Dr B Some Pharmacological Effects of Staphylolysin on the Isolated Rat Uterus, 2017
Wieland, T Macromolecules (Organic Chemistry of the Formation of Peptide Links), 1690
Wightman, F R, and others Plant Growth Regulation (Metabolism of Indole Auxins in Plants), 599
Wigner, Eugene P (Weinberg, Alvin M, and) The Physical Theory of Neutron Chain Reactors, *review* by Dr J Walker, 1973
Wilbraham, Anne (Drummond, the late Sir Jack, and) The Englishman s Food, revised by Dorothy Hollingsworth, *review* by Dr Leslie J Harris, 484
Wilcox, Dr J Thermonuclear Processes (Propagation of Torsional Alfvén Waves through Plasma), 241
Wild Horse, *Equus przewalskii* The Mongolian (A G Bannikov), 1024, (E Dagva), 1024, (D Tzevegmid), 1024, (I S Sles), 1024
Wild Rabbits Age Determination in (R H Taylor), 1158
Wild-Type Isoalleles (Different) Effect of, on Crossing-over in *Drosophila melanogaster* (M M Green), 294
Wilden-Hart, M E At the Annual Conference of the Library Association (Observations on County and Municipal Practice), 1455
Wildy, P, and others Deoxyribonucleic Acid Formation in Multiplying HeLa Cells, 107
Wildy, P (Taverne, Janice, and) Purification of Herpes Simplex Virus by Chromatography of Calcium Phosphate, 1655
Wilkes, Dr Maurice V Awarded a Silver Medal of the City of Paris, B A 16
Presidential Address to the first Conference of the British Computer Society, 945
Wilkins, Dr H Percy Observations of the Russian Moon Rocket *Lunik II*, 502
Wilkins, L T, and Mannheim, Herbert Personnel Management and Technological Change (Operational Problems of the Borstal System), 1615
Wilkins, Dr M B Animal Clocks (Plant Clocks), 764, 1534
Wilkinson, D, and others Identification of the High-Temperature Constituent in Mild Steel Surface-Hardened by Carbo-Nitriding, 1312
Wilkinson, Prof D H Turning Points in Physics (Towards New Concepts —Elementary Particles), *review* by G R Noakes, 1090
Wilkinson, F (Porter, Prof G and) Fast Chemical Reactions in Solution, 1453
Wilkinson, J B The Electric Arc in Welding, 1031
Williams, Prof B R (Carter, Prof C F, and) Science in Industry—Policy for Progress, 1827
Williams, C N Resistance of *Sorghum* to Witchweed, 1511
Action of Inhibitor-β on the Growth of *Striga* Seedlings 1577
Williams, C N, and Caswell, G H An Insect attacking *Striga*, 1668
Williams, C N, and others Stone Implements from Western Nigeria, 124
Williams, D J, and others Studies of Coal—Carbonization of Coals in the Presence of Activated Charcoal, 425
Williams, D Lloyd (Murray III, Arthur, and) Organic Syntheses with Isotopes, Part 2, Organic Compounds labelled with Isotopes of the Halogens, Hydrogen, Nitrogen, Oxygen, Phosphorus and Sulfur, *review* by Dr G Eglinton, 1830
Williams, F Black Marlin in British East African Waters, B A 78
Williams, H H, and others Effect of Amino-Acid Imbalance' on Growth and Vitamin A Storage in the White Rat, 1404
Williams, I C Appointed lecturer in zoology at the University of Hull, 1273
Williams, L H The Future of Chemicals from Petroleum (Fifth Levinstein Memorial Lecture of the Society of Chemical Industry), 1915
Williams, R B (Carter, C F, and) Investment in Innovation, *review* by Prof A J Brown, 1348
Williams, Dr R J P Deposition of Trace Elements in Basic Magma, 44
Williams, Dr R J P, and others Energy Transfer with special reference to Biological Systems (Chelates of Iron as Models for the Understanding of the Variations in Spectrum and Redox Potential of the Cytochromes), 690
Williams, Dr S Plant Morphology, *review*, 84
Williams, S A, and others Stone Implements from Western Nigeria, 124
Williams, Dr T F (Dole, Prof M, and) Energy Transfer with special reference to Biological Systems (Disappearance of Unsaturated Linkages on γ-Irradiation of Polyethylene), 689

Williams, Trevor I, and others (edited by) A History of Technology, Vol 5, The Late Nineteenth Century, *review* by Dr Leonard Carmichael, B A 5
Williams, Watkin Heterosis and the Genetics of Complex Characters, 527
Williams-Ashman Dr H G, and others Two Enzymic Mechanisms for Hydrogen Transport by Phenolic Œstrogens, 427
Willis, Dr E H (Godwin, Dr H, and) Radiocarbon Dating of Prehistoric Wooden Trackways, 490
Willis, Dr J B Determination of Magnesium in Blood Serum by Atomic Absorption Spectroscopy, 186
  At the Second Australian Spectroscopy Conference (Determination of Blood Serum Calcium and Magnesium Levels by Atomic Absorption), 1197
Willis, Dr J B (Ham, Dr N S, and) At the Second Australian Spectroscopy Conference (Infra-red and Raman Spectra of some Isothiocyanates) 1196
Willis, V Gas Chromatography (Application of Gas Chromatography to Process Stream Monitoring), 328
  Analysis of Permanent Gases by Gas Chromatography using a Radioactive Ionization Type Detector, 894
Willmer, Dr E N Cell and Organ Culture, 935
Willoughby, Dr D A Pharmacological Suppression of Increased Capillary Permeability following Irradiation of the Intestine of Rats, 1156
Wills (Australia), Ltd, W D and H O Grant of £3,500 towards the cost of the third Summer School for Science Teachers of the Australian Nuclear Research Foundation, 1108
Wilman, H, and others A Theory of the Abrasion of Solids such as Metals, 333
Wilmer, Helen L Measures of Delinquency Prevention and their Effectiveness, 1203
Wilms, A H, and others Coal Science (Carbonization—Strength of Coke in relation to Particle Size of Coal Carbonized), 413
Wilson, Dr A (Ruddock, R, and) After Work—Leisure and Learning in Two Towns, 1034
Wilson, A F Precambrian Geology of South-western Australia, 237
Wilson, Dr A T Surface of the Ocean as a Source of Air-borne Nitrogenous Material and other Plant Nutrients, 99
  Paper Chromatography of Cell Fragments, 2016
Wilson, Prof Cecil L, and Wilson, David W (edited by) Comprehensive Analytical Chemistry, Vol Ia, Classical Analysis, *review* by Dr William I Stephen, 1756
Wilson, Prof C T R *Obituary* by Prof Norman Feather, 1842
Wilson, C V, and others (C F H Allen, in collaboration with) Six-Membered Heterocyclic Nitrogen Compounds with Three Condensed Rings, *review* by Dr F G Mann, 216
Wilson, Dr David M Catalytic Processes and Petroleum, *review*, 1090
Wilson, David W (edited by Prof Cecil L Wilson and) Comprehensive Analytical Chemistry, Vol Ia, Classical Analysis, *review* by Dr William I Stephen, 1756
Wilson, jun, Prof E Bright *Obituary* of Prof William Moffett, 21
Wilson, Dr E M Appointed senior lecturer and director of computation in the University of Southampton, 1915
Wilson, James A, and others Oxygen Uptake of Glycerol-extracted Muscle Fibres, 1947
Wilson, Dr J Yanney Simultaneous Change in both Differential and Interference Distances of Chiasmata, 207
Wilson, Prof P W (Bush, J A, and) A Non-Gummy Chromogenic Strain of *Azotobacter vinelandii*, 381
Wilson, Prof R Nuclear Forces and the Few-Nucleon Problem (The Primary Two-Nucleon Interaction), 1113
Wilson, R B (Kipling, J J, and) Coal Science (Ultra-fine Structure of Coals and Chars—Sorption of Gases and Vapours on Chars prepared by Carbonizing Synthetic Polymers), 413
Wilson, Dr Tuzo The Structure of Science, B A 6
Winchester, David P (Wolfson, Dr Albert, and) Effect of Photoperiod on the Gonadal Cycle in an Equatorial Bird, *Quelea quelea*, 1658
Wind (Solar) The Aurora, the Radiation Belt and the—a Unifying Hypothesis (M H Rees and G C Reid), 539
Windaus, Prof A O R *Obituary* by Prof G A D Haslewood, 150
Winder, Dr C V Aspirin and Algesimetry, 494
Winder, Frank, and Denneny, Joan M Effect of Iron and Zinc on Nucleic Acid and Protein Synthesis in *Mycobacterium smegmatis*, 742
Windle, W, and Cundy, E K Clay Minerals (Occurrence of Zinnwaldite in Cornwall), 780
Windows (Interfacial Micro-) Wear Observations through (Robert H Savage), 45
Windscale Accumulation of Radioactive Iodine in Thyroid Glands subsequent to Nuclear Weapon Tests and the Accident at (Dr Hamish A Robertson and Ian R Falconer), 1699
Windsor, Dr Maurice W Volcanoes on the Moon, 1556
Wine, in Beer and other Beverages Carbon Dioxide in Water, in (F Justin Miller), *review* by Dr A H Cook, 302
Winkelmann, R K, and Schmit, Robert W Action of Ribonuclease on Nerve Axoplasm as Demonstrated by Silver Staining, 553
Winkler, H Molecular and Atomic Motions in Liquids and Solids by Radiofrequency Methods, 158
Winn, M M (Ogilvie, K W, and) Evidence for Cosmic Ray Energy Spectrum Changes during a Forbush Decrease, 888
Winocour, Ernest (Sachs, Dr Leo, and) Formation of Different Cell–Virus Relationships in Tumour Cells induced by Polyoma, 1702
Winter Flounder (*Pseudopleuronectes americanus*) Failure of Corpuscles of Stannius from, to Synthesize Adrenocorticosteroids *in vitro* (Dr J G Phillips and Dr P J Mulrow), 558
Winter-Hardiness of Insects Possible Rôle of Glycerol in the (P Dubach, D Pratt, Prof F Smith and C M Stewart), 288
Winteringham F P W, and Harrison, A Mechanisms of Resistance of Adult Houseflies to the Insecticide Dieldrin, 608
Wintle, H J Velocity of Sound in Relaxing Gases, 2007
Winzor, W J (Creeth, J M, and) Structure and Chemistry of Proteins (Specificity of the Reaction of Iodine with the Sulphydryl Groups of Ovalbumin), 1277
Wirbeltiere Die gesunden und die erkrankten Zahngewebe des Menschen und der, im Polarisationsmikroscop (Prof W J Schmidt und Dr A Keil), *review* by Prof A I Darling, 218
Wisdom, Dr J O Scientific Research and the Philosophy of Science, 1193
Wisdom of the West (Bertrand Russell), edited by Paul Foulkes, *review* by Gerd Buchdahl, 1829
Wiseman, L A The British Rayon Research Association—Open Days, 600
Wistar Institute of Anatomy and Biology, Philadelphia (Dr R E Billingham and Dr H Koprowski), B A 6
  Symposium on the Structure of Science, B A 6
Witchweed Resistance of *Sorghum* to (C N Williams), 1511
Withdrawal Noradrenaline and Adrenaline in the Rat Brain during Acute and Chronic Morphine Administration and during (Dr Lars-M Gunne), 1950
Witt, Georg Polarization of Light from Noctilucent Clouds 1618
Witt, H T Fast Chemical Reactions in Solution (Chlorophyll with particular reference to Primary Processes of Photosynthesis), 1453
Wittenberg, Prof Jonathan B Formation of the Porphyrin Ring, 876
Wittig, F E Thermodynamics (Physical Constants), 1608
Wlodarczak Dr K, and Jeljaszewicz, Dr J Influence of Coagulase on the Growth of Staphylococci in Normal Human Serum, 1514
Wnekowska, L Coal Science (Chemical Reactions of Coal—Thioether Groups in Coal) 413
Wojtczak Lech (Chmurzynska Wanda, and) Interaction between Thiourea and Insect Polyphenoloxidase, 1941
Woledge R C and others Fusion Frequency and Light Quantity, 1873
Wolf, Dr E Fluctuation Phenomena and Stochastic Processes (Coherence Properties of Partially Polarized Light), 511
Wolf, M (Prince, Dr Morton B, and) Awarded the Marconi Premium of the British Institution of Radio Engineers, 857
Wolfrom Melville L, in association with R Stuart Tipson (edited by) Advances in Carbohydrate Chemistry, Vol 13, *review* by Dr Alfred Gottschalk, 662
Wolfe, Louis H, and others Relationship of *p*H to Aerobic Corrosion Fatigue Life of Steel, 2008
Wolfenden, Sir John The University of Leicester *review*, 1975
Wolfs, P M J, and others Coal Science (Carbonization—Carbonization of Synthetic Polymers containing Aromatic Units linked by Methylene Bridges labelled with Radioactive Carbon), 413
Wolfson, Dr Albert, and Winchester, David P Effect of Photoperiod on the Gonadal Cycle in an Equatorial Bird, *Quelea quelea*, 1658
Wollman, E (Jacob, F, and) Cytoplasmic Inheritance (Lysogeny and Zygotic Induction), 1012
Wolstenholme, G E W, and O'Connor, Cecilia M (edited by) Ciba Foundation Symposium on Medical Biology and Etruscan Origins, *review* by Madeleine Smith, 1348
Woman (Turkish-Cypriot) A Haemoglobin with Unusual Alkaline-denaturation Properties in a (Dr J E O'N Gillespie, Dr J C White, M J Ellis, Dr G H Beaven, W B Gratzer, Dr E M Shooter and R M E Parkhouse), 1876
Womersley, Dr H B S, and Norris, Dr R E A Free-Floating Marine Red Alga, 828
Wood, E J Ferguson An Unusual Diatom from the Antarctic, 1962
Wood, Marian (Rook, Dr J A F, and) Potassium and Lactose in Milk in relation to the Physiology of Milk Secretion, 647
Wood, M B, and Warwick, C S Geomagnetic Disturbance and Velocity of Slow-Drift Solar Radio Bursts, 1471
Wood, M R, and others Delayed Hypersensitivity ('Tuberculin-like' Reactions to Trichophytin in Guinea Pigs), 1030
Wood, R B (Jackson, Dr G A D, and) Presence in Rose Hips of Substances Inhibiting the Oxidation of Ascorbic Acid, 902
Wood, R J (Birkett, L, and) Shell and Siphon Regeneration in *Mactra stultorum* Linne (Lamellibranchiata), 1075
Wood, W A Atomic Mechanisms of Fracture (Fracture during Fatigue), 325
Wood (Drift-) Transport of, from South America to Tasmania and Macquarie Island (Prof H N Barber, Dr H E Dadswell and H D Ingle), 203
Woodbine, Dr M Appointed to a readership in agricultural microbiology in the University of Nottingham, 410
Woodbridge, Dr Richard C (Woodbridge, III, Richard G, and) Application of Ultra-Violet Lights to Underwater Research, 259
Woodbridge, III Richard G, and Woodbridge, Dr Richard C Application of Ultra-Violet Lights to Underwater Research, 259
Wooden Trackways (Prehistoric) Radiocarbon Dating of (Dr H Godwin and Dr E H Willis), 490
Woodger, Prof J H Title of professor emeritus in the University of London conferred on, 508
  Biology and Physics, 1193
Wooding, Dr E R Fluctuation Phenomena and Stochastic Processes (Recombination in a Plasma as a Stochastic Process), 511
Woodlands Water and (International Association of Scientific Hydrology, Publication No 48), 1184
Woodruff, Prof M F A, and others An Improved Technique for Intravenous Injection of Newborn Rats and Mice, 1952
Woods, E F Electronic Prediction of Swarming in Bees, 842
Woods, E F, and others Structure and Chemistry of Proteins (Soluble Wool Proteins) 1277
Woods, H J Biological Fibres, B A 25
  Fibre Surface Replication by Rolling, 1478
Woods, R G Appointed deputy librarian of the University of Southampton, 595
Woods Hole Marine Biological Association Grant of 105 000 dollars from the United States National Science Foundation, 683
Woods Hole Oceanographic Institution Grant of 250 000 dollars from the United States National Science Foundation, 683
  Grant of 3 000,000 dollars from the United States National Science Foundation, for a new Research Vessel, 1686
Woodward, J Personnel Management and Technological Change (Contribution of Industrial Sociology to Management Education), 1614
Woodward, Prof R B Awarded the Davy Medal for 1959 of the Royal Society, 1189, 1834, work of, 1834
Woodworth, Prof Robert S Dynamics of Behavior, *review* by Prof O L Zangwill, 1523
Woody Plants (Deciduous) treated in Autumn with Gibberellic Acid Extended Dormancy of (Dr P W Brian, J H P Petty and P T Richmond), 69
Wool Action of Mixed Solvents on (J C Atkinson, [illegible] Filson and Prof J B Speakman), 444

  Hydroxylysine in (Helga Kersten and L Zurn), 1490
  Influence of Dietary Protein Percentage on Growth of (K A Ferguson), 907
  A Lesion of the Follicle and of the Fibre of, and its Possible Relation with an Excess of Iron in the Forage (Prof G Gonzelez, J Garcia and E Fernandez), 559
  Measurement of the Rate of Growth of, using Cystine labelled with Sulphur-35 (A M Downes and A G Lyne), 1884
Wool from Copper-deficient Sheep Experiments on (R W Burley and F W A Horden), 1725
Wool in Sheep Loss of, caused by 1-*p*-Aminophenoxy-5-phthalimidopentane (Dr D L Hughes), 1644
Wool (Merino) Routine Methods for Determining Quality in (P L le Roux), 917
Woolf, A L, and others Ultra-structure of the Myoneural Junction in Myasthenia Gravis, 1500
Work, T S, and others Protein Biosynthesis and Oxidative Phosphorylation in Isolated Rat Liver Mitochondria, 165
Work An Anthropologist at—Writings of Ruth Benedict (Dr Margaret Mead), *review* by Prof E E Evans-Pritchard, 301
  After—Leisure and Learning in Two Towns (R Ruddock and Dr A Wilson), 1034
Work of Newspaper Trusts (Political and Economic Planning, Broadsheet No 435), 1687
Work (Recent), on the Electron Microscopy of Viruses (Dr Kenneth M Smith), 1440
Worker The Ageing, 318
  Fitting the Job to the—a Survey of American and European Working Conditions in Industry (European Productivity Agency of the Organization for European Economic Co-operation, Project 335), 422
Working Conditions in Industry (American and European) Fitting the Job to the Worker—a Survey of (European Productivity Agency of the Organization for European Economic Co-operation, Project 335), 422
Working Lives of Men Age and the (F Le Gros Clark), 318
Working Party on Higher Education in East Africa, 1958 Report of the, 243
Working up Processing Mixtures containing Anhydrous Aluminium Chloride A New Method for (Dr T Széll and A Furka), 117, *erratum*, 595
Workshops Replicas of, 1534
World The Very Cold, *review* by Prof J F Allen, 1260
World of Learning, 1958-59, ninth edition, *review*, 489
World (Animal), of Netherlands New Guinea (Dr L D Brongersma), *review* by J E Hill, 1261
World (New) Education in the, 81
World Distribution of Atmospheric Water Vapour Pressure (G A Tunnell), B A 15
World Health Organization (United Nations) Technical Report Series No 154, Post-Graduate Training in the Public Health Aspects of Nuclear Energy (Fourth Report of the Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel), 33
  Technical Report Series No 171, Mental Health Problems in Old Age, 1844
World Health Organization and the Food and Agriculture Organization (United Nations) School-Feeding Seminar for countries in South and East Asia, 420
World Meeting on Veterinary Education (Food and Agriculture Organization of the United Nations), 943
World Meteorological Organization Technical Note No 25, Design of Hydrological Networks (Max A Kohler) Technical Note No 26, Techniques for Surveying Surface-Water Resources (Prof Ray K Linsley), 96, *erratum*, 684
  Technical Note No 27, Use of Ground-Based Radar in Meteorology (excluding Upper-Wind Measurements), 942
World Veterinary Association Establishment of a, 853
  Election of Prof W I B Beveridge as president of the Permanent Committee, 853
World War II Surgery in, Neurosurgery, Vol I (Colonel John Boyd Coates, editor-in-chief), *review* by J E A O'Connell, 1676
World's Fauna Man and the (Dr L Harrison Matthews), B A 43
Worlds The Internal and the External (Sir Cyril Hinshelwood), 1834
Worms (Lug-), *Arenicola marina* (L) Local Races in (Dr A Duncan), 71
Worrall, Dr W E (Roberts, Prof A L, and) Clay Minerals (Study of a German 'Fireclay Mineral'), 780
Worshipful Society of Apothecaries of London Foundation of a Faculty of the History of Medicine and Pharmacy, 1448
  Inaugural Lecture to the Faculty of the History of Medicine and Pharmacy (Canon Charles E Raven), 1448
Worthington, Dr E B Biological Problems arising from the Control of Pests and Diseases, 1100
  Nature and Agriculture (Sir Thomas Middleton Memorial Lecture), 1535
Worthington, L V, and Metcalf, W G Polar Front Survey (Hydrography—Salinity/Potential Temperature Relationship in the North Atlantic Deep Water), 1182
Worzel Deep-Sea Ash Origin of the (Edward Anders and Dr D Nelson Limber), 44
Wound Healing and Tissue Repair (edited by W Bradford Patterson), (Developmental Biology Conference Series, 1956, under the auspices of the United States National Academy of Sciences—National Research Council), *review* by Dr D R Newth, 839
Wounds (Apple Stem) *Gloeosporium* in (R O Sharples), 243, (A T K Cooke), 244
Woycicki, W Thermodynamics (Experimental Thermochemistry), 1607
Wragg W R, and others Congeners of Pempidine with High Ganglion-blocking Activity, 1707
Wren, J J A Concave Concentration Gradient of Methanol in Chloroform employed in Elution of Lipids from Silicic Acid, 816
Wright, Dr C A Evolution of Host–Parasite Relationships (Relation between Trematodes and Molluscs), 762
  Parasitic Animals, *review*, 1011
Wright, Dr D A Appointed first professor of applied physics in the University of Durham, 1022, work of, 1022
Wright, Dr D E Hydrogenation of Lipids by Rumen Protozoa, 875
Wright, J K Thermonuclear Research (Shock Waves in Gases), 1017
Wright, J R, and Schnitzer, J Oxygen-containing Functional Groups in the Organic Matter of a Podzol Soil, 1462
Wright, M L M Science by the Upper Form (Physiography and Scenery of the Isle of Eigg), 596
Wright, Dr M R (Porter, Prof G, and) Energy Transfer with special reference to Biological Systems (Processes of Deactivation involving Change of Multiplicity), 689
Writer The Technical (J W Godfrey and G Parr), *review* by A L Bacharach, 1749
Writing Science, *review* by A L Bacharach, 1749
Wunderlich, Jeffrey A, and others Structure of Cellobiose, 1719
Wyatt, Dr Stanley P Solar Effects in the Motion of *Vanguard*, 351
Wyllie, Dr G Fluctuation Phenomena and Stochastic Processes (Brownian Motion of Spin Systems), 511

X-IRRADIATED Mice (Lethally) Abrogation by Injected Mouse Blood of Protective Effect of Foreign Bone Marrow in (L J Cole and R M Garver), 1815
X-Irradiation Structure of Thymine Hydroperoxide produced by (B Ekert and R Monier), B A 58
X-Irradiation (Whole-body) Effect of, on the Insulin Resistance of Fasted Rats (Dr V Stankovic and N Sestan), 1816
  Metabolic Changes induced in Mammalian Erythrocytes by (Prof D A Rappoport and B W Sewell), 846
X-Radiation Effect of, on the Survival of Yeast in Dry and Wet Conditions (A Mookerjee), 1502
X-Ray Crystallography The Powder Method in (Prof Leonid V Azaroff and Prof Martin J Buerger), *review* by Prof H Lipson, 1599
X-Ray Damage and Recovery in Mammalian Cells in Culture (M M Elkind and Harriet Sutton), 1293
X-Ray Diffraction by Carbons Effects of Heating on (Eitaro Matuyama), 544
X-Ray Diffraction Pattern of Carbide in Low-Carbon Iron-Silicon Alloys (G Konoval, L Zwell, L A Gorman and W C Leslie), 1862
X-Ray Induced Ageing Latent Period of—a Study based on Mortality Rate and Tumour Incidence (Dr H I Kohn and Dr P H Guttman), 735
X-Ray Induced Inhibition of Deoxyribonucleic Acid Synthesis in *Escherichia coli* 15_T Influence of Unbalanced Growth on subsequent (Daniel Billen), 174
X-Ray Irradiations in *Culex fatigans* Wied (1828) Induced Mutations of (R Pal and B S Krishnamurthy), 658
X-Ray Microanalysis X-Ray Microscopy and (International Symposium on), 860
X-Ray Microscopy and X-Ray Microanalysis (International Symposium on), 860
X-Ray Powder Methods, *review* by Prof H Lipson, 1599
X-Ray Sensitivity and Target Volume of Enzyme Induction (Dr Helmut Pauly), 1570
X-Ray Study of Rigid-Body and Internal Vibrations of Organic Molecules (Dame Kathleen Lonsdale and Dr H Judith Milledge), 1545
X-Rayed Seeds of High and Low Water Content Free Radicals in, as Measured by Electron Spin Resonance (Dr W Klingmuller, Dr G R Lane, M C Saxena and Dr D J E Ingram), 464
X-Rays Influence of, on the Activity of Carbonic Anhydrase in Erythrocytes and on their Haemolytic Resistance (A Lauwers, J Van Bavinchove and W Dierick), 111
Xanthine Oxidase Activity A Rapid and Sensitive Method for the Determination of, using the Oxygen Electrode (Metry Bacila and Dr Gilberto G Villela), 1394
Xanthomonas spp (Plant Pathogenic) Some New Specific Bacteriophages for (Z Klement), 1248
Xerophilous Equatorial Bird, *Quelea quelea* Duration of the Regeneration Period of the Internal Reproductive Rhythm in a (H J de S Disney, B Lofts and Dr A J Marshall), 1659
Xiphinema sp Rôle of a Dagger Nematode, in Outbreaks of Plant Diseases caused by Arabis Mosaic Virus (Dr B D Harrison and Dr C H Cadman), 1624
  Transmission of a Virus to Strawberry Plants by a Nematode (Asharfi Jha and Dr A F Posnette), 962, *erratum*, 1192
Xylenes, Cresols and Toluidines Separation of the *Meta-* and *Para-*Isomers of the, by Gas Solid Chromatography (M A Hughes, D White and Prof A L Roberts), 1796
Xylose Discrimination of, from Arabinose and some other Sugars (B Drozdz), 1395
D-Xylose Glycolaldehyde Trapped from Aerobic Oxidation of, by *Torulopsis utilis* (V Bolcato and G Leggiero), 1318

YAGI, Dr Hirofumi, and others Effect of Flavins on Cramp caused by Phenol, 1648
Yagi, Dr Kunio, and others Complex Formation of Chlorpromazine with Flavins, 982
  Effect of Flavins on Cramp caused by Phenol, 1648
  Change of Absorption Spectrum of Flavin Adenine Dinucleotide by its Binding with both D-Amino Acid Oxidase Apo-Protein and Benzoate, 1938
  Occurrence of Polynucleotide Phosphorylase in Atypical Epithelioma of Rat, 1939
Yagi, Dr Kunio, and Nagatsu, Dr Toshiharu Formation of Noradrenaline from Adrenaline by Rat Liver Mitochondria, 1316
Yagi, Dr Kunio, and Ozawa, Takayuki Binding of the Sulphydryl Group in D-Amino-Acid Oxidase Apo-Protein with Flavin Adenine Dinucleotide, 1227
Yajima, Toshikatsu, and others Changes in Purine Nucleotides of Red Lateral Muscle of Rainbow Trout, 1415
Yale University Appointment of Dr D J Price as visiting professor of the history of science, for the academic year 1959-60, 95
  Fourteenth Annual Calorimetry Conference, 1194
  Hugh M Huffman Memorial Lecture (Prof George S Parks), 1194
Yalow, Dr Rosalyn S, and Berson, Dr Solomon A Assay of Plasma Insulin in Human Subjects by Immunological Methods, 1648
Yamagata, Noboru Concentration of Caesium-137 in the Coastal Waters of Japan (1959), 1813

Yamamoto, Dr Robert T , and Fraenkel, Prof G Common Attractant for the Tobacco Hornworm, *Protoparce sexta* (Johan) and the Colorado Potato Beetle, *Leptinotarsa decemlineata* (Say), 206
Yamano, Togo, and others Microbiological Transformation of a Cardiac Aglycone, 469
Yamashita, Hideo Awarded a Silver Medal of the City of Paris, B A 16
Yangambi Moisissures du Sol et des Litières de la Region de (J Meyer), 236
Yapp, W B A Controversial Equation in Population Ecology, 1582
Yashouv, A , and Chervinsky, J Hybrids of *Tilapia nilotica* x *T galilea*, 1739
Yates, J R , and others Structure and Chemistry of Proteins (Rôle of Thiols in Disulphide Interchange Reactions), 1277
Yeast Effect of X-Radiation on the Survival of, in Dry and Wet Conditions (A Mookerjee), 1502
Yeast on Glucose Changes in Adenosine Di- and Tri-phosphate Concentrations in the Early Stages of the Action of (Dr J O Laws and Dr L H Stickland), 1246
Yeast (Brewer's) Effect of Oxygen on Endogenous Metabolism of a Respiratory-deficient (V E Chester), 1956
Yeast Cells Release of Nucleotides from (Masataka Higuchi and Prof Teijiro Uemura), 1381
Yeast Enzyme Enzymic Reduction of α-Aminoadipic Acid by (S Sagisaka and Prof K Shimura), 1709
Yeasts Nuclear Structure of Growing Naked Protoplasts of (Dr O Necas), 1664
Yellow Adipose Tissue (Brown and), of the Bat Lipase Activity in the (Prof J C George and J Eapen), 59
Yellow Lupins High Levels of Phosphorus and Die-Back in (R G Warren and B Benzian), 1588
Yellow (Turnip) Mosaic Virus Nucleoprotein Particles with Differing Biological and Physical Properties (R E F Matthews), 530
Yellowstone Park Earthquake (E Tillotson) 955
Yettram, A L Appointed lecturer in civil engineering at the University of Leeds, 684
Yoffe, A D (Bowden, Dr F P , and) Fast Reactions in Solids, *review* by Dr Peter Gray, 664
Yolk Nucleus in the Oocytes of some Fishes Development of the (Prof A Stolk), 1746
Yonatani, T (Chance, Prof Britton, and) Energy Transfer with special reference to Biological Systems (Fast Simultaneous Recordings of Cytochrome Reduction and Diphosphopyridine Nucleotide Reduction), 690
Yorkshire Council for Further Education, and others Symposium on Recent Developments in Textile Chemistry, 1845
Yoshida, M Effect of Acetylcholine and Eserine on the Spawning of *Hydractinia echinata*, 1151
Youell, Dr R F Clay Minerals (X-Ray Data on Heat-treated Silicates), 780
Young, B G , and others Reduction of Toxicity of Cationic Macromolecules by Complexing with Anionic Derivatives of Synthetic Polyglucoses, 431
Young, Dr G H S Chemistry of Propellants (Solid Propellants—Burning Rate Control), 779
  Rocket Propulsion (British Solid Propellants for Rockets), 1266
Young Darwin and the 'Origin of Species' (Prof C F A Pantin), 1533
Youngdahl, C A , and DeBoer, F E Analysis for Magnesium in High-Purity Aluminium, 54
Youngman, B J 'Parsnip' Dermatitis, 594
Youth Employment Executive (Central) Pharmacy as a Career, 95
Youth Service in Britain Nature Conservation and (Brigadier E F E Armstrong), 685 , (Edie J Green), 685
Yudkin, Prof John (Morgan, Dr T B , and) Thiamine-sparing Action of Sorbitol in Rats and Mice, 909
Yudkin, Prof John (Watson, J D , and) Effect of Sorbitol on the Urinary Excretion of some B Vitamins in Man, 911, *errata*, 1362
Yugoslavia Nuclear Reactor *RB* Accident in, 406
Yukawa, Prof Nuclear Forces and the Few-Nucleon Problem (Scattering of Nucleons by Light Nuclei at High Energy), 1113

ZAANEN, Prof Adriaan C An Introduction to the Theory of Integration, *review*, 574
Zacharias, B , and others Affinity of Lysozyme to Structural Elements of the Bacterial Cell as studied with Enzyme Labelled with Radioactive Iodine, 1744
Zaher, Dr M A , and Moussa, Dr Moufied A Relationship between Larval and Pupal Periods of some Lepidopterous Insects, 288
Zahn, Dr Rudolf K A Biological Action of Deoxyribonuclease I on the Growth of *Euglena gracilis*, 1324
Zahngewebe des Menschen und der Wirbeltiere im Polarisationsmikroscop Die gesunden und die erkrankten (Prof W J Schmidt und Dr A Keil), *review* by Prof A I Darling, 218
Zahradník, Rudolf An Attempt at Calculating the Taft's-Constants σ*, 1865
Zaitlin, Prof Milton Isolation of Tobacco Leaf Cells capable of Supporting Virus Multiplication, 1002
Zaitsev, Dr G N , *et al* Polar Front Survey (Hydrography—Greenland and Norwegian Seas), 1181
Zakrzewski, J T , and Mehrtens, D H Use of the Silicon Resistor in the d c Stabilization of Transistor Circuits, 811
Zamenhof, Prof Stephen (Ephrati-Elizur, Dr Erela, and) Incorporation of 5-Bromouracil into Transforming Principle of *Bacillus subtilis* and its Biological Effects, 472
Zanandrea, Dr Giuseppe Speciation among Lampreys, 380
Zangwill, Prof O L Perception and Learning, *review*, 1523
Zar, L , and Irving, Prof J T Effect of Vitamin D on the Respiration of Rat Oral Tissue, 1410
Zarek, Dr J M Biomechanics 512
Zawels, Jakob, and others Transistor Electronics, *review* by J W R Griffiths, 838
Zea mays L in Canada Isolation of the Antifungal Substance, 6-Methoxybenzoxazolinone, from Field Corn (N J Whitney and C G Mortimore), 1320
Zebra Fish Variations in Early Cleavage of the (A W Marrable), 1160
Zebu Cattle β-Globulin Alleles in some (G C Ashton), 1135
Zeitlin, Dr R A Blood Group Methods and Techniques, *review*, 130
Zelikoff, M (edited by) The Threshold of Space—the Proceedings of the Conference on Chemical Aeronomy, sponsored by the Geophysics Research Directorate, Air Force Cambridge Research Center, Cambridge, Mass , 1956, *review*, 1011
Zelnicek, Dr E α-Ketoglutaric Acid and Pyruvic Acid in Blood, Cerebrospinal Fluid and Urine, 727
Zemla, J , and others Infectious Ribonucleic Acid from Mouse Brains infected with Tick-borne Encephalitis Virus, 1581
Zenith Reactor at Winfrith Heath (United Kingdom Atomic Energy Authority), 680
Zenneck, Prof J *Obituary* by Dr R L Smith-Rose, 1188
Zero Gradient Synchroton at Argonne National Laboratory, 503
Zijlstra, Dr W G , and others Intravascular and Intracardiac Blood Velocity Patterns recorded by means of *NTC* Resistors, 991
Zimm, Dr B H (Haltner, Dr A J , and) Rotational Friction Coefficients of Models of Tobacco Mosaic Virus and the Size of the Virus Particle, 265
Zimmer, K G Biological Effects of Low Doses of Ionizing Radiations (Review of certain Aspects of Quantitative Radiobiology), 1111
Zimmermann, Prof K At the Conference of the Mammal Society of the British Isles (Rodents collected in China), 30
Zinc Effect of Iron and, on Nucleic Acid and Protein Synthesis in *Mycobacterium smegmatis* (Frank Winder and Joan M Denneny), 742
Zinc Oxide Effect of Gamma-Radiation on the Synthesis of Methanol over (T I Barry and R Roberts), 1061
Zinc Phosphide Particles Absorption of (Dr A S Curry, Dr D E Price and Dr F G Tryhorn), 642
Zinc Single Crystals Fatigue-Induced After-Effect in (A H Meleka and G B Dunn), 896
Zinc and Radiozinc Behaviour of, in Tumour-bearing Rats (Dr D M Taylor), 1649
Zirconium Volatile Methoxides of Aluminium and (Dr D C Bradley and Dr M M Faktor), 55
Zischka, W , and others Production of Serum Albumin and of Globulins by Chick Mesenchymal Tissue and by HeLa Tumour Tissue in Culture, 361, *erratum*, 943
Zlatkis, Prof Albert, and Kaufman, H R Use of Coated Tubing as Columns for Gas Chromatography, 2010
Zone Lenses Deviation of, produced by Polarization (Prof Jurgen R Meyer-Arendt), 811
Zone-Refined Lead Recrystallization of (G F Bolling), 718
Zones (Electrophoretic), in Agar Gel Direct Spectroscopic Examination of (Dr G H Beaven and W B Gratzer), 359
Zoogeography, Phytogeography and Geology Panbiogeography, or an Introductory Synthesis of (Dr Leon Croizat), Vol 1, The New World , Vol 2a, The Old World , Vol 2b, The Old World (continuation), *review* by Prof Ronald Good, 924
Zoological Nomenclature, International Commission on Given accommodation in the British Museum (Natural History), 156
Zoological Society of London Christmas lectures, 1535
Zoological Survey of Madagascar (Dr Renaud Paulian), 1387
Zsifkovits, St , and others Effect of Sexual Maturation and Castration on the Sex Chromatin Pattern in the Male Rat, 1239
Zsoldos, F Quantitative Changes in γ-Aminobutyric Acid induced by Low Temperature in Rice Plants, 280
Zuckerman, Sir Solly Liberty in an Age of Science, 135
  Appointed chairman of the Committee responsible for controlling Government-financed scientific research and development, 684
  Appointed scientific adviser to the Ministry of Defence, 1105 , work of, 1105
Zuelzer, Dr W W , and others Separation of Fast-Moving γ-Globulins by Starch-Gel Electrophoresis, 1800
Zumpt, Dr F Is the Multimammate Rat a Natural Reservoir of *Borrelia duttoni*?, 793
Zurn, L (Kersten, Helga, and) Hydroxylysine in Wool, 1490
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Printed in Great Britain by Fisher, Knight & Co , Ltd , The Gainsborough Press, St Albans,
and published by Macmillan & Co , Limited, at St Martin's Street, London, W C 2,
and St Martin's Press, Inc , 175 Fifth Avenue, New York 10 N Y , U S A
Saturday, 21 May 1960